INDIAN SCIENCE CONGRESS
LUCKNOW 1953
PART IV

PROCEEDINGS
OF THE
FORTIETH
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LUCKNOW 1953

PART IV
LATE ABSTRACTS, DISCUSSIONS, LIST OF MEMBERS AND INDEX

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PART IV

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1. LATE ABSTRACTS

Section I, Mathematics.

23. The Equations of the Affine Field Theory of the Mixed type.

S. N. Bose, Calcutta.

Einstein has developed a unitary theory which leads to the following relations between the g's and the Γ's

$$g_{\mu\nu,k} = g_{\mu\lambda}\Gamma^{\lambda}_{k\nu} + g_{\lambda\nu}\Gamma^{\lambda}_{\mu k}.$$

These 64 equations can be decomposed into groups of 40 and 24 equations. Denoting

$$\Gamma^{\lambda}_{\mu\nu} = B^{\lambda}_{\mu\nu} + V^{\lambda}_{\mu\nu},$$

the first denoting the symmetric and the second the antisymmetric parts of $\Gamma^{\lambda}_{\mu\nu}$, the determination of the 24 $V^{\lambda}_{\mu\nu}$ can be reduced to the tensor equation

$$U_{\sigma\mu\nu} = T_{\sigma\mu\nu} + T_{\sigma kl}C^{k}{}_{\mu}C^{l}{}_{\nu} + C^{t}{}_{\sigma}(T_{t\mu l}C^{l}{}_{\nu} + T_{tk\nu}C^{k}{}_{\mu})$$

The solution of this equation can be determined in the form

$$T_{\sigma\mu\nu} = \sum_{b \neq c} \frac{U_{xyz}M^{x}{}_{a}\bar{M}^{\sigma}{}_{a}M\binom{yz}{bc}M\binom{\mu\,\nu}{bc}}{1+ab+bc+ca},$$

where M, $\bar{M}$ are the eigen vectors of the matrices c, $\bar{c}$ and (ab . . .) are the eigen values of the matrices.

Singular cases are discussed and finally the result is transformed into terms of matrices c, $\bar{c}$ and certain other matrices derived from them.

24. Axially Symmetrical Stress-distribution in Transversely isotropic materials.

U. P. VENKATACHARAI, Hyderabad-Deccan.

This paper deals with axially symmetrical stress-distribution in transversely isotropic materials. It is shown that all stresses and displacements can be expressed in terms of a single stress function. Considering different types of solutions, the problems of bending of symmetrically loaded aeolotropic plates, the problems of a force at a point in an infinite solid and many others such as symmetrical loading of cylinders, rotating shafts and discs, etc. can be solved.

25. On the Absolute Summability of Fourier series by Riesz's logarithmic means.

B. N. PRASAD (Allahabad) *and* M. L. MISRA (Sagar).

A series $\sum_{n=1}^{\infty} c_n$ is said to be summable by Riesz's logarithmic mean of order α or summable (R, log n, α) to the sum s if

$$R_\alpha(\omega)=\frac{1}{(\log\omega)^\alpha}\sum_{n<\omega}\left(\log\frac{\omega}{n}\right)^\alpha c_n \quad (\alpha\geqslant o)$$

tends to a limit s, as $\omega\longrightarrow\infty$. After Obrechkoff [Math. Zeits. 30 (1929), 375-385], a series Σc is said to be absolutely summable by Riesz's logarithmic mean of order α or summable $|$ R, log n, α $|$ $(\alpha\geqslant o)$, if

$$\int_A^\infty |\,d\,R_\alpha(\omega)\,|<\infty$$

where A is a positive number greater than 1.

We write

$$\phi(t)=\tfrac{1}{2}\{f(x+t)+f(x-t)-2s\},$$

$$\Phi_\alpha(t)=\frac{1}{\Gamma(\alpha)}\int_t^\pi\left(\log\frac{u}{t}\right)^{\alpha-1}\frac{\phi(u)}{u}du \quad (\alpha>o),$$

$$\Phi_o(t)=\phi(t)$$

In this paper we prove the following :

THEOREM. *If* $\phi_\alpha(t)$ *is of bounded variation in* (o,π), *then the Fourier series of* f (t) *is summable* $|$ R, log n, β $|$ *at the point* $t=x$, *where* $\beta>\alpha+1$ *and* $\alpha\geqslant o$.

This theorem connects the absolute logarithmic summability of Fourier series of a function with the bounded variation of the logarithmic mean of the function and is comparable to the corresponding theorem of Bosanquet on absolute Cesàro summability (L. S. Bosanquet, Proc. London Math. Soc. (2) 41 (1936), 517-528).

26. Fermat's Last Theorem.

S. C. GHOSAL, Lucknow.

Supposing $(p^n+q^n)=r^n$, when p and q are +ve and n is an odd prime, it follows that $(p+q)=a^n$ or $=a^n.\ n^{sn-1}$;

$$\left.\begin{aligned}&\text{and if } P=(p+q)^{\frac{n-1}{n}}\\&\text{and } Q=\left(p^{\frac{n-1}{}}\ \dots+q^{n-1}\right)^{\frac{1}{n}}\end{aligned}\right\}\text{ Or }\left\{\begin{aligned}&P=(p+q)^{\frac{n-1}{n}/n^{1/n}}\\&Q=\left(p^{\frac{n-1}{}}\ \dots+q^{n-1}\right)^{\frac{1}{n}}\Big/\frac{1}{n^n},\end{aligned}\right.$$

it can be shown that

$pq<$ or $=(P\text{-}Q)$, and at the same time $pq>(P\text{-}Q)$; hence $(p^n+q^n)\neq r^n$, when p, q, r are +ve integers and n is an odd prime number.

Other cases of −ve values of p and/or q and for other values of n can be derived from this.

Section III, Physics.

42. Raman Spectra of Calcite.

P. G. Puranik, Hyderabad (Dn.).

With a view to study the second order lines, the Raman Spectrum of Calcite has been recorded using a Hilger, Littrow E. 182 Quartz spectrograph and λ2536 radiation for excitation.

Appearance of Raman line 864 cm^{-1}, reported earlier by R. S. Krishnan has not been confirmed. Two new lines one at 1674 cm^{-1} (broad) and another at 2837 cm^{-1} (weak) have been reported for the first time.

43. On the Study of Bi-partition and Tri-partition of Uranium-nucleus.

S. P. Dutta, Calcutta.

In the present paper binary and ternary fissions of Uranium under the action of slow neutron have been studied by Photographic emulsion technique and it is intended to establish the fact that in the case of tripartition the third fragment may not necessarily be a light particle, of nature of *a*-particle, but can have a mass greater than 4. Accordingly it was necessary to desensitize the experimental nuclear plates by increasing the concentration of $UO_2(NO_3)_2$, $6H_2O$ in alcohol. A concentration of 12 to 16% was found most favourable due to various factors. More than 20,000 cases of bi-partition and one interesting case of tri-partition were observed. The calculated mass values were 166, 43 and 30; but from the nature of ionisation, the mass value of the third fragment is expected to lie between 15 to 20 instead of 30. The calculated Kinetic energy of this tripartition is 2×10^9 electron-volts instead of $1{\cdot}5 \times 10^8$ electron-volts and hence it is assumed that the fission has been initiated by a high energy fast neutron (of Cosmic-ray origin) the direction and value of which only can help to determine the correct mass values. In such highly desensitized plate the total range distribution of the two fission fragments has been shown by a histogram and most of them lie between 20 and 21μ. The corresponding value in a non-desensitised plate is 24μ approximately.

44. Some Results of Solar Prominence Observations Recorded at Kodaikanal from 1904-1950.

R. Ananthakrishnan *and* P. Madhavan Nayar.

The results of solar prominence observation made at Kodaikanal during the 1st half of this century which covers four sunspot cycles have been analysed and tables of mean daily areas of prominences for each five degree latitude zone have been worked out for the NE, NW, SE and SW quadrants of the sun's disc for all the years. The results have been represented in the form of a number of charts and the salient features brought out by these diagrams are discussed.

45. Analysis of the angular correlation experiment with report of such measurements on Ni^{60}.

S. Chatterjee *and* A. K. Saha, Calcutta.

A complete analysis on the requirements for the measurement of angular correlation function has been made. The difficulty in such measurements lies in the fact that in general the anisotrophy is very small so that unless error 6 W in the correlation function W is kept low it would be difficult to detect any anisotrophy. In this paper a general expression for τ, the total time of observation to keep 6 W to a desired value, has been derived in terms of source strength, efficiency of the counters and geometry of the counters. Charts have been presented on the basis of this expression which indicates what the experimental arrangement should be and which also suggests a number of improvements that have been made on existing arrangements. Results of the measurements of angular correlation of Ni^{60} has also been given. The correlation function W for Ni^{60} has been found to be 1·16 (±1·4 per cent) which is in conformity with the results obtained by Brady and Deutsch (1950). This result does not agree with Das and Sen (1951) whose high value of W = 1·47 has been explained. Theoretical expression of the effect of scattering on the correlation function has been given and this agrees well with experimental findings. It has been shown that the effect due to scattering is independent of the counter geometry but decreases with increase of the efficiency of the counters. The effect of the angular spread due to the finite geometry of counters, on the angular correlation function has also been calculated. The degree to which such effects of angular spread can modify the angular correlation has been shown. In conclusion further improvements on the experiment have been suggested. The level scheme suggested by Das and Sen does not stand and that suggested by Brady and Deutsch holds.

46. Theoretical Investigation on short lens spectrometer.

M. K. BANERJEE *and* A. K. SAHA, Calcutta.

Twenty-two electron trajectories have been obtained by numerical integration of the equation of motion. An analysis of the results of the calculation shows that the magnetic lens behaves as an optical lens with crossed principal planes. Although spherical and chromatic aberration effects are present in the expression for focal length, the locations of the principal planes are surprisingly constant.

A method of obtaining the line shape for ring focussing has been developed. It has also been shown that a continuous baffle system defining the upper caustic surface of the rays completely eliminates the low-current tail of the line shape.

Line shape has been obtained for an extended source, using Keller's result for skew rays.

47. The Analysis of the Relaxation Periods of a Multivibrator.

RAIS AHMED *and* D. C. SARKAR, Aligarh.

An improved mathematical analysis of the relaxation periods of a free running multivibrator has been made showing expressions for the various electrode potentials and time periods. The theoretical values obtained have been compared with experimental data.

Section IV, Chemistry.

319. Sex Hormones Metabolism in Pregnant Indian Buffaloes.

AKHLAQ R. KIDWAI (Aligarh).

The chemical examination of the pregnancy urine of Indian buffaloes was undertaken in order to obtain the products of sex hormones metabolism. The urine, after being brought to *p*H 1 with H_2SO_4, was added to 2·5% excess of H_2SO_4 an subjected to hydrolysis by refluxing for two hours. The hydrolysate was the submitted to exhaustive extraction with ether. The etherial extract was fractionate into acidic, phenolic and neutral fractions, which are now being further fractionate for the isolation and characterization of the sex hormones metabolic products.

Section V, Geology and Geography.

81. Effects of High Waves on the Formation of Coastal Black San Deposits.

C. MAHADEVAN *and* A. SRIRAMA DAS, Waltair.

In the month of December, 1951, unusually thick and extensive black sa deposits were noticed on the Vizagapatam beach. During that time, there was storm, 650 miles away in the bay, resulting in the increase in wave height from 2 to 12 feet near the Vizagapatam coast, but with no rain. One of the black sand patches showed an estimated accumulation of 10,000 tons, and the laboratory analysis of samples collected showed interesting relationship between the percentages of various minerals like monazite, zircon, garnet, etc. and the mechanical composition. The above concentration of black sands is attributed to the selective erosion of the beach due to the increase in the wave height. This is in conformity with the observations of Shepard, La Fond and Grant.

82. Some Physical Properties of Micas from parts of Vizagaptam District (Madras).

C. Mahadevan *and* N. Sathapathi, Waltair.

The physical, optical and dielectric properties of about a dozen interesting specimens of mica from parts of Vizagapatam, have been studied. On the basis of the optical orientation and axial angle, the micas have been divided into the muscovite system, of the heptaphyllite group, and lepidolite system and biotite system, of the octophyllite group. On the basis of colour, the biotite system seems to contain the phlogopites and the black micas. With a few exceptions the colourless as well as the coloured micas show correlatable relationship between their axial angles and dielectric constants. The white micas with fall of elasticity, transparency and axial angle show a corresponding decrease in the dielectric constants. In the coloured micas, with increase of the intensity of the colour, the values of their dielectric constants rise.

The exceptional nature of some, to the above inter-relationship, is attributed to certain variations in the structural and compositional properties of the micas.

One of the coloured micas, has resemblance to the species, mahadevite in certain physical properties and optical orientation but with low axial angle.

83. Pyroxenes from the Charnockite-Khondalite Interaction Zone of Waltair.

A. Srirama Das, Waltair.

About 120 grains of pyroxenes from an interaction zone of charnockites and khondalites have been studied with respect to optic axial angle $Z \wedge C$ value, pleochroism and other optical properties.

From the detailed optical properties, it is possible to divide the pyroxenes broadly into three groups. The first group is characterised by the $Z \wedge C$ value, 0°, distinct pleochroism, negative sign, and optic axial angle about 60°, the second group by the $Z \wedge C$ value more than 24°, nonpleochroic, positive sign, and optic axial angle about 60°; and the third group by the $Z \wedge C$ value 2° to 24°, plechroic, negative sign and optic axial angle about 60°.

The first group is inferred to be ortho-pyroxene, the second clinopyroxene and, the third, a link between the ortho and clinopyroxenes, evolved in the process of paragenesis due to interaction of charnockite and khondalite. Such group of pyroxenes has not been reported so far.

84. Appositional Fabric study of the Coastal Sedimentaries of parts of East Godavary District.

A. Srirama Das, Waltair.

An attempt is made to know the direction and nature of agent of transport and thereby the interrelationship of coastal sedimentaries of parts of East Godavary district by appositional fabric analysis. Considerable part of the work is devoted to develop techniques of preparing specimens for dimensional fabric analyses and a convenient circular scale is devised to make measurements required for the fabric analysis. The appositional fabric, whose basic principle is that the ellipsoidal grains orient with the broad ends upstream, yielded results indicating a marine, shallow water origin for the coastal sedimentaries. This conclusion agrees with all other field observations.

85. The Clouded Felspars of the Dolerite Dykes, Nellambakkam (Madras).

A. BHASKARA RAO, Waltair.

During an investigation of the area south of Pallavaram two dolerite dykes were met with near Nellambakkam, cutting across charnockites. Both of them are dark-coloured with slight variation in granularity. They exhibit ophitic texture and are constituted of plagioclase felspars and pyroxenes.

The plagioclases are all twinned and are absolutely fresh. They have numerous dust-like inclusions of magnetite with a colourless narrow margin devoid of inclusions. This feature is typical when the plagioclases are enclosed in pyroxenes. There is a marginal concentration of these inclusions in the pyroxene grains suggesting diffusion from the adjoining laths of plagioclase. The twin lamellae continue throughout the laths irrespective of the concentration or otherwise of the inclusions.

The felspars of the associated charnockites are fresh and are devoid of cloudiness.

It is suggested that diffusion operating through small distances might be the cause for the inclusion-free narrow margins of the plagioclases especially when they are surrounded by pyroxenes which are having marginal concentration of these inclusions.

86. Optically positive Hypersthene from Acid Charnockite, Chromepet (Madras).

A. BHASKARA RAO, Waltair.

During the optical examination of the charnockites from the Chromepet area, a few of the hypersthene grains in the acid variety showed some anomalies, which are recorded in this paper.

Prismatic crystals of hypersthene, in one of the sections of a coarse grained acid variety of charnockite, have a deep pleochroism with the angle between 'Z' and 'C' being 6°. These are optically positive and have an optic axial angle of 60°-70°.

Chemical analysis of the mineral shows that it has about 6% alumina and more molecular magnesia than iron.

The alumina might have affected the mineral constitution tending to vary the optic axes to a newer position, with 'Z' as acute bisectrix; resulting in the positive optic sign for hypersthene.

87. Paragenesis of Nepheline in the Felspathoidal Rocks of Koraput, Orissa.

N. SATHAPATHI, Waltair.

The nepheline bearing rocks of Koraput occurring to the N.E. of the town, are confined to a few anticlinal hills. The syenite hills are constituted of massive, coarse grained, nepheline rich felsic rocks at the top, fine grained banded and bedded nepheline syenites on the flanks, bedded alkali syenites at the base and bedded khondalites at the foot-hill region. All the rocks associated with the syenite hills including the surrounding khondalites are conformable in attitude. Across strike, from summit to the foot of the hills, the banding and bedding become more and more distinct and prominent, the grain size and the amount of nepheline decrease, the microperthite increases, and the albite and plagioclases increase in the beginning but decrease towards alkali syenites. All the syenitic rocks contain minerals that show lateral and peripheral variation in composition, representing two or more minerals in a single grain. The irregular grains of nepheline contain inclusions of microperthite, albite and plagioclases which grade into each other and into the enclosing mineral. Besides these banded and bedded igneous looking rocks, pyroxenites, gabbros, nepheline gabbros, syenites, granite pegmatites and some basic dykes, of igneous origin, are found. The above rocks are intrusive into the khondalites, the oldest rocks of the area. The pyroxenites, the oldest of the igneous rocks, are cut by the nepheline syenites which in turn are cut by the granites the youngest of the igneous family. The contact zones of khondalites with most non-felspathoidal intrusives are syenitised into nepheline free rocks.

From the above facts, it appears that a felspathoidal magma formed in a complex way with a genetical relationship with other magmas of the area, has either by itself and/or through its desilicated emanations has metasomatically altered khondalites into felspathoidal rocks.

88. Structural Petrology of some Quartzites of Palnad.

M. SRIRAMA RAO, Waltair.

Quartzites of different horizons in the Cuddapah-Kurnool succession occurring in the hill range along the south of the Palnad taluk are compact, and have two sets of well-defined joints trending E.N.E.-W.S.W. and N.N.W.-S.S.E. They are highly folded and overturned and thrust over the younger Palnad limestones. They strike N.E.-S.W. veering to E.N.E.-W.S.W. and N.N.E.-S.S.W. and exhibit foliation especially in the rather ferruginous varieties. Lineation is N.N.W.-S.S.E. Microscopically, the various quartz grains show Bohm lamellae, undulose extinction, and sutured boundaries.

The greatest concentrations of optic axes are seen in the Byrenkonda (Nullamalais), Irlakonda and Srisailam (Kistnas) quartzites; the Banganapalli quartzitic sandstones have poor maxima. The quartzites are *B* tectonites characterised by *a c* girdles in the fabric diagrams. Distinct two-girdle pattern is observed in the Nullamalai quartzites.

The direction of tectonic transport seems to be in a plane running roughly N.E.-S.W. The Banganapalli quartzitic sandstones have probably suffered one deformation while most of the Cuddapah quartzites are the result of two independent deformations in different periods.

89. Plagioclase Twinning in some Charnockitic Rocks.

A. BHASKARA RAO *and* M. SRIRAMA RAO, Waltair.

An investigation of the plagioclase felspars of the charnockites of the Eastern Ghat region, with particular reference to twinning, is made and the results are briefly outlined in this paper.

The acid, intermediate and basic members of the charnockite group of rocks contained various species of the plagioclase felspars, which are, in general, twinned. The untwinned ones are relatively more common in the acid and intermediate rocks. There is the prevalence of complex twins consisting of many sub-individuals with the predominence of Albite-Carlsbad and Albite-Ala. These are the various types of twinned which are met with: Baveno, Menabach, Albite, Ala A, Ala B, Carlsbad, Albite-Ala, and Albite-Carlsbad. Normal twins, Albite and Manebach are present in the acid rocks, whereas Albite-Ala, Ala, Carlsbad and Albite-Carlsbad are found in the basic rocks. Varied types of twins are present in the intermediate rocks. Complex twins seem to become more and more abundant with increase in anorthite content of plagioclase.

The observations suggest that the basic charnockites are of igneous origin, and that the acid and intermediate charnockites are probably the result of metasomatic process in metamorphism.

90. Heavy Minerals of the Gondwanas of parts of West Godavari District.

M. SRIRAMA RAO *and* A. T. RAMACHANDRA RAJU, Waltair.

The Barakar and Chintalapudi sandstones of Lower Gondwana age and the Gollapalli sandstones, Raghavapuram shales and Tripati sandstones of Upper Gondwana age occurring in the Zangareddigudem area have been investigated with particular reference to their heavy mineral assemblages.

The shapes, inclusions and weathering tendencies of quartz and felspar in the light fraction are studied. Tourmaline is a constant inclusion in the sand grains of both Upper and Lower Gondwanas.

The Chintalapudi sandstones are very simple as far as their heavy mineral assemblage is concerned. Antipathic relation between yellow and colourless varieties of Zircon and also between Garnet and yellow Zircon is noted.

It is difficult to sharply subdivide the Upper Gondwanas on the basis of their mineralogical content. Staurolite is of diagnostic value in the Upper Gondwanas. The Gollapalli sandstones resemble the Tripatis in their physical characters; and the heavy mineral suites of both are the same with a minor difference in their frequencies. Raghavapuram shales retain their individuality both physically and mineralogically. The presence of minerals like sillimanite, garnet, staurolite, kyanite, etc. in the heavy residues of Upper Gondwanas indicates a metamorphic terrain as a possible source of the sediments. Mineralogically, the Upper Gondwanas of the Godavari district do not appear to resemble those occurring to the south of the Kistna, at Budavada, Pavalur and Kandukur. The correlation of the different patches of the Upper Gondwanas of the East Coast has been attempted.

91. A Note on the occurrence of the Karharbari stage and some new plant fossils in the Jainti Coalfield, Bihar.

S. N. PURI, Geological Survey of India.

During the re-survey of the Jainti coalfield (Deoghur coalfields), Bihar, the author collected some plant fossils from the mud-stones, nearly a furlong S.S.E. of Misra (24°10′ : 86°40′, sheet No. 72 L/12). This collection has a two-fold importance:

1. It contains fronds of *Gondwanidium validum* and *Buriadia sewardi*, which are typical Karharbari fossils. Their presence indicate that the beds are probably parts of the Karharbari stage not hitherto recognised in the area.

2. There are some new forms, *e.g.*, a gymnospermous cone and a portion of a doubtful fertile shoot, which do not appear to have been reported from the Indian Lower Gondwana sediments. Being fragmentary, their generic identification is difficult to determine. The morphological characters of the rest of the fossils have been described and their affinities suggested, so that these could be compared with similar other specimens in future. The latter forms have been tentatively referred to as *Phyllotheca sp.*, *Cordaicarpus sp.*, and *Squama forma integerrima.*

The note also describes *Samaropsis raniganjensis* and *Noeggerathiopsis hislopi* found from the same beds.

Phyllotheca and *Samaropsis raniganjensis* have not so far been described from the horizons below the Barakar and the Raniganj stages respectively. Besides the discovery of a new fossil locality, their presence together with *Gondwanidium* and *Buriadia* suggest that the lower range of these fossils require a revision.

92. Coral reefs of the Gulf of Manaar as a source of high grade lime.

A. K. DEY and V. GOPAL, Madras

Authors investigated the Recent coral reefs occurring as disconnected masses fringing the isles in the Gulf of Manaar off the Tirunelveli-Ramanathapuram coast and estimated about two million tons of reef material analysing over 52 per cent CaO, upto 2 per cent SiO_2, 1 per cent R_2O_3 and 1 per cent MgO. The industrial possibilities of these depend on the rate of growth and replenishment after removal about which definite information has to be collected.

93. Rainfall Trends in India.

S. K. PRAMANIK *and* P. JAGANATHAN, Poona.

It is often stated that the climate and, in particular, the rainfall is changing—decreasing at certain places and increasing at certain others. In this paper, the rainfall trends in India and Pakistan as a whole have been examined with the help of available rainfall records. Rainfall records of 30 selected observatory stations, for which long and continuous data are available have been examined.

The main results are:

(1) There appears to be no significant short period cyclical movement in the annual rainfall at the different stations except at Bhuj, where an oscillatory tendency of length about 8-12 years may be present.

(2) The distribution of rainfall in the major parts of India, particularly in the arid and semi-arid regions of northwest India and the semi-arid regions of the Deccan, show that there is a general tendency for deficient rainfall to be more

frequent than it would be if the rainfall distributions were normal, while in the sub-Himalayan regions of North and Northeast India there is a slight tendency for rainfall in excess of the mean to be more frequent.

(3) Analysis by fitting polynomials to the annual rainfall series indicates increasing linear trends in the case of Kozhikode, Bellary, Nagpur and Jalpaiguri and decreasing trend in the case of Visakhapatnam. In addition trends of some higher order have been indicated in some of the stations.

(4) Further examination with the aid of 10-year moving averages for the places showing trends by the polynomial analysis, shows that there is no general tendency for increase or decrease in the case of any of the stations.

(5) Polynomial analysis of seasonal rainfall at stations where annual rainfall indicated linear trends by polynomial analysis shows decreasing trend of southwest monsoon rainfall in the case of Visakhapatnam and a slight increasing trend in the case of the southwest monsoon rainfall of Kozhikode, Bellary, Nagpur and Jalpaiguri. There is significant increasing trend in the January to March rainfall of Nagpur.

(6) Examination of the 10-year moving averages of seasonal rainfall at the places shows that there has been no general tendency for increase or decrease at any of the places, but the average June to September rainfall during 1931-1940 of Vishakapatnam was significantly lower than the mean rainfall and the January to March rainfall of Nagpur for 1941-1950 and the October to December rainfall of Jalpaiguri for 1921-1930 were significantly higher than the mean rainfall for the season.

94. The Geographical Basis for the Pattern and Distribution of Rural Settlements in Kerala.

V. A. JANAKI, Baroda.

The paper considers the subject of "geographical environment" in its widest sense, that is, it includes within its field not only physical, economic and historical influences but also cultural and communal influence, thereby opening a new chapter in socio-geography. The interplay or differential force of such factors determine the site, distribution, pattern, size, function and morphology of Settlements.

The term "rural" also needs to be explained. The classification of rural and urban settlements in Kerala (and incidentally in the whole of India) has no functional basis. The decision rests entirely on its numerical strength, that is, a settlement of less than 5,000 people is termed "rural". Secondly a rural settlement as understood in Kerala, is not a village as in other parts of India; rather it is a conglommeration of houses, so that the 'house' and not the 'village' is the unit of settlement in this region. The second factor has given Kerala its unique dispersed pattern of settlements which stands out in striking contrast to the settlements on the east coast. The paper sets out to prove that this unique feature is the product of geographical environment. It also proves that the nucleated settlements (generally exceptions in this region) are also the product of environmental factors.

The author realises the difficulty of giving one single reason for the formation of these two types of Settlements rather a particular type of Settlement is due to a combination of factors.

The paper then classifies dispersed and nucleated settlements into several patterns such as :—

I. DISPERSED SETTLEMENTS

(1) Linear pattern
(2) Uniformly spaced pattern
(3) Semi-grouped pattern.

II. NUCLEATED SETTLEMENTS

(1) Elongated or rectangular
(2) T shaped often modified into a cross
(3) Irregular or radial pattern

and proves that each pattern is the result of the above mentioned factors of geographical environment.

The paper concludes that there is a close relationship between geographical environment and the distribution and pattern of Settlements. However the author admits that the conclusion is arrived at by a study of the geography of Kerala alone.

95. Relative relief and the distribution of Waste Land in the Naravagedda Basin.

V. L. S. Prakasa Rao, Madras.

The paper records the results of the author's preliminary investigation into the aspect of relative relief and the problem of wasteland in Naravagedda Basin lying between 83· 3′ W and 89· 20′ E and Lat. 17· 40′ S and 17· 57′ N. The area is spotted with a number of 'inselbergs'—monadnocks and ranges—and each one of them has a waste and sometimes ravine land all round. The distribution of waste land in the area under study is patchy due to the highly scattered nature of the hills and hill ranges. Extensive waste land is primarily due to the erosion environment of the basin. Land slopes both absolute and relative, and soil types (red earths and lateritic soils) are more contributory to erosion than the incidence of rainfall. Of the cultural factors, neglect of the hillsides, and over-stocking with uncontrolled grazing are very significant. Unsystematic and random quarrying for building materials is another factor contributing its own share particularly to gully erosion in the foot hill zones in the vicinity of towns and large villages.

The following slope categories have been worked out for the area.

Grade.	*Land Slope.*	*Relative Relief.*	*Land Category.*
	%	feet.	
A	<0·2	< 50	Marsh.
B	0·2 to 1	<100	Cultivated land.
C	1—7—11	100—300—500	Wasteland.
D	>11—13	700—900	Gully eroded and ravine lands.

It can be said that the disposition of C and D grades and the steep gradient of relative slopes are favourable to gully erosion.

96. Regionalism in India.

S. Muzaffar Ali, Aligarh.

India is one of the great units of the earth and is in a wide sense one political and one cultural pattern. The word 'India' forms a convenient unit for reference in many respects. But this is a broad generalisation of facts—a generalisation which is supposed to fit nearly two million sq. miles and nearly forty million people of India who have had a long period of time during which to develop different kinds of regionalism into fairly significant patterns. The regional diversities are not yet clear and clean cut, but the distinctions of regional or sectional parts of our country range from funny paper to serious political issues. The paper reviews some of the more obvious Indian regionalism and makes some tentative observations about regionalism as such in India.

Section VI, Botany.

124. *Puccinia Cacao*, a Heteroecious Rust.

M. J. Narasimhan, Patna.

Puccinia cacao McAlp. inciting leaf rust of Rottbelia *compressa* Roxb. a noxious weed grass, occurs in several places in India and is also reported from China, Japan and Formosa. Only uredia and telia were known uptil now, the spore forms being produced during the months from November to April. Detailed morphological and cultural studies indicated that the rust is heteroecious developing aecial and pycnial stages on *Hygrophila spinosa*, a member of the Acanthaceae. On this host the rust incites systemic infection suppressing the development of spines which are very prominent in a healthy plant. The rust oversummers chiefly by the perennial mycleium within the subterranean root stocks.

The teliospores were germinated and sporidial inoculations of young leaves of *H. spinosa* yielded successful infections after 20 days. The mycelium usually moved down from the point of inoculation and by affecting the apical meristem produced systemic infection. The aecial stage uptil now unrecorded from India had previously been described under the name *Aecidium manilense* by Arthur and Cummins from the Philippines. Inoculating leaves of *Rottboelia compressa* with the aeciospores from *H. spinosa* resulted in the development of uredia within 12 days during the month of March.

125. Temperature and the Stem Rust of Wheat.

ABRAR M. KHAN, Aligarh.

Seedling of wheat varieties recommended by the Agriculture Department, Uttar Pradesh, were inoculated with race 42 of stem rust and the plants were kept at 18°C ± 3°, but the rust failed to appear. Hence the inoculum was tested for its viability and positive results were obtained. The experiment was repeated thrice and fresh inoculum was obtained each time from the assistant Mycologist, Simla. The viability of spores was tested before inoculating the plants. Again the rust failed to develop. However when these plants were transferred to a room having a temperature of 30°C, the rust postules appeared within the period of 4-5 days.

The rust did not develop in the plants inoculated with race 42 of *Puccinia grannis tritici* Eriks. and Henn., in plants kept at 18°C for over two months. Probably, low temperature retards the development of stem rust and extends incubation period. It appears that is why the stem rust does not show up in the fields in the Aligarh District during the early stages of wheat plants when the temperature is rather low.

126. *Fusarium Roseum* Link and *Sclerotium Rolfsii* Sacc. on Ginger Rhizomes.

B. S. MEHROTRA, Allahabad.

Two fungi, viz., *Fusarium roseum* Link and *Sclerotium rolfsii* Sacc. isolated from ginger (*Zingiber officinale*) rhizomes are here recorded.

Fusarium has never been reported occurring on ginger except for a mere mention of an unidentified species of *Fusarium* causing basal-rot, reported from Hawaii. The inoculation experiments have shown that the fungus is an occasional secondary or wound invader of ginger rhizomes. A detailed morphology of the fungus is given in the text of the paper.

Sclerotium rolfsii Sacc. is here reported from India, for the first time, on ginger. Inoculation experiments have shown that the fungus occurs only superficially leaving the rhizome apparently sound.

Section VII, Zoology and Entomology.

88. The problem of the discontinuous distribution of Harpodon nehereus.

SUNDRA RAJ (Colombo).

Harpodon nehereus (Bombay Duck) has a wide but discontinuous distribution along the coasts of East Africa, Asia and Indonesia. The author has filled some gaps in the hitherto known range.

The extreme limits are roughly 40° N. to 10° S. and 40° to 122° E. Long.

The following remarkable co-relations are noted :—

1. The summer 80°F. isotherm reduced to sea level almost exactly coicides with the distribution of the fish.
2. The occurrence of the fish is closely related to the S. W. monsoon both in time and place.
3. The places of greatest abundance are the estuaries of the S. W. monsoon fed rivers.
4. The fish appear to be absent even in monsoon affected areas where banks and islands protect the coasts.

Recent researches and the above co-relations seem to support Gunther's theory that *Harpodon nehereus* is a deep sea fish which periodically comes near the surface.

1. All other Harpodon species except one are deep water forms.
2. Their chief food in the open sea appears to be Bregmoceros, a fish which occurs down to 400 fms.
3. Progressive diminution of catches after September indicates that the fish are receding into deeper water.
4. Inshore fish at height of season have undeveloped gonads and eggs and larval forms are absent. Specimens caught 50 to 60 miles off Bombay had mature gonads. The migration is therefore presumed to be for breeding purposes.
5. As islands and submarine banks seem to act as barriers to the landward migration of the fish from adjoining deeper seas, the fish are presumably bathy-pelagic or meso-pelagic. Bombay Duck has never been recorded from the deep sea, probably because deep sea expeditions so far have not investigated fish at intermediate levels.

89. The Morphology of the Reproductive organs in Chiroptera.

K. R. RAMASWAMY, Nagpur.

The present work embodies the description of the genitalia in the male and female of species of bats.

1. *CYNOPTERUS sphinx gangeticus* (Fam. Pteropidae)
2. *PIPISTRELLUS babu* (Fam. Vesportilionidae).
3. *LYRODERMA lyra lyra* (Fam. Megadermatidae).

The genitalia of *CYNOPTERUS* differs from that of the other Megachiroptera in having a single non-septate vagina. *PIPISTRELLUS* is typically Vespertilionid in its genital morphology. *LYRODERMA lyra lyra* is peculiar in showing physiological assymmetry of the female genitalia and the collection data clearly shows that there is an alternation in the horns that became pregnant at successive times.

The paper also contains a discussion on the homologies of the seminal vesicles and ampullae of Henle in the Chiroptera.

Section VIII, Anthropology and Archaeology.

15. From History to Pre-history in Western India.

H. D. SANKALIA, Poona.

The writer reviews briefly the most important results of the exploration and excavations conducted by the Deccan College Research Institute, Poona, at Kolhapur, Nandur-Madhmeshwar, Nasik, Gangapur and Jorwe from 1943 to 1951 and points how these help in giving a cultural sequence backwards from the Andhra-Satavahana-Roman times back to the Lower Palaeolithic through the intermediary copper bronze ages and the Mesolithic periods. This sequence is true at present only of the Deccan (Maharashtra).

16. Viragals of Hiregundu gallu.

K. NARAYANA IYENGAR, Bangalore.

The author describes and discusses the value of some of the inscriptional records found in the herostones or "Viragals" from this place for the reconstruction of the early mediaeval history of the region.

Section IX, Medical and Veterinary Sciences.

63. Studies on Plasmodium gallinaceum Brumpt: Preliminary notes on experimental infections in domestic fowls by sporozoites.

P. SEN, Calcutta.

Plasmodium Gallinaceum infection can be transferred by Aedes aegypti mosquitoes when their salivary glands showed the presence of sporozoites. These mosquitoes when fed on experimentally infected fowls showing gametocytes of the parasite took up the infection readily. The incidence of infection however differed during the various months. In the month of August it was 20 per cent which came down to 15 per cent in September and the rate was only 8 per cent during the next two months. The Plasmodium took 11 to 12 days to develop into the sporozoite stage in the salivary glands of *A. aegypti* during the months of August and September, whereas in October a longer time of 18 to 20 days was required. In November it took as long as 25 days. During the latter month the development of the parasite was much retarded often culminating in degenerated oocysts and black spores.

A healthy fowl successfully infected through the bites of a sporozoite-carrying female *Aedes aegypti* mosquito took about two weeks to develop the Plasmodium parasites in its blood. The month of August appears to be the most favourable transmission season for this bird malaria.

Experiments were carried out with this species of mosquitoes such as *aedes albopictus, culex fatigans* and *Anopheles stephensi,* but these did not give encouraging results. The parasite can grow only partially in *albopictus.*

Attempts were also made to transmit the parasite in a monkey through the bites of infected Aedes mosquitoes, but the animal did not take up the infection.

64. Paludomus Obesa as a possible vector of human schistosomiasis in India.

S. Rammohan Rao, R. K. Gadgil *and* S. N. Shah, Bombay.

Some Fercocercus type of cercaria which are morphologically indistinguishable from that of Schistosoma haematobium cercaria have been found in Paludomus obesa a snail which has a very limited distribution in this country. The possibility of this snail serving as a possible vector of Urinary Schistosomiasis in this country is emphasised. A number of cases of Schistosomiasis in human beings due to S. haematobium infection from Chiplun, Ratnagiri District, Bombay State, have been recorded. Schistosomiasis seems to be endemic in this area and the persistence of this infection in that village may not have been possible if the local snails did not have any miracidial attraction leading to the infection and an ultimate development of the cercaria successfully in the body of the intermediate host. An attitude of complacence on the part of the Medical and the Zoological workers is very much deplored and a very strong plea is made for complete elucidation of this problem of the vector.

65. Schistosomiasis in Elephants in Bombay State.

S. Rammohan Rao *and* L. S. H. Regaudar, Bombay.

"A natural case of Schistosomiasis in Elephants due to *Ornithobillharzia nairi* has been recorded."

66. Observations on the Treatment of Foot and Mouth Disease.

M. R. Dhanda, V. R. Gopalarishanan *and* H. S. Dhillon.

Details are given of the experiments carried out to asses the therapeutic value of five drugs and substances, claimed to be effective against Foot and Mouth Disease infection. These were :—

1. Aphtisine-131, which appears to be a biological product of Roland Bordet Laboratories, Paris.
2. Skimmed milk.
3. Marking nuts.
4. 'MOKHUR'—a homoepathic drug and
5. Wilco Foot and Mouth cure, also a homoepathic drug.

None of these was found to have any beneficial effect against the artificial infection with Foot and Mouth Disease virus, either as a curative or as a prophylactic.

Observations on the chemotherapeutic treatment of other workers elsewhere are discussed.

The work has been carried out under a Scheme of research financed by the Indian Council of Agricultural Research, India.

Section X, Agricultural Sciences.

50. Studies on the Activity of Manganese in Calcareous Soils—II.

P. B. BHATTACHARYA, P. K. BANERJEE *and* K. L. KHANNA, Pusa, Bihar.

Activity of soil manganese and corresponding inhibition of nitrification were studied under calcareous soil conditions with smaller doses of sulphur added in increasing amounts. Manganese of the active category—water soluble, exchangeable and reducible—and nitrate-nitrogen were estimated after 1st, 2nd, 3rd, 5th and 7th week of addition of sulphur. Treated soils show higher manganese activity at all levels in the first few weeks, while in treatments with higher sulphur doses manganese activity is maintained till the seventh week. Depressing effect of sulphur on the progress of nitrification is, however, noticeable with the lowest dose of sulphur.

51. Azotobacter Activity in Calcareous Soils.

P. B. BHATTACHARYA *and* L. L. SRIVASTAVA, Pusa, Bihar.

Suitability of different phosphatic salts to azotobacter activity in the calcareous soil of Pusa was tested on soil plagues. Alkaline tripotassium phosphate showed the highest density of growth, next in order of growth were plagues treated with neutral disodium and dipotassium hydrogen phosphates. Acidic potassium dihydrogen phosphate showed the least growth. No development of colonies was obtained either with ammonium phosphate or triple superphosphate treated plagues.

52. Manganese Distribution in Sugarcane Soils of Bihar—I.

P. B. BHATTACHARYA, K. L. JONEJA *and* K. L. KHANNA, Pusa, Bihar.

Determination of total and active manganese contents of major soil groups in the Sugarcane tract of Bihar, and a study of their depth distribution in normal profiles indicate high total and active manganese in the heavy clay group. Calcareous soils contain the least and the non-calcareous group of soils occupy an intermediate position in respect of this element in both the categories. Manganese, of the exchangeable form is, however, highest with the non-calcareous group of soils due mainly to the more or less neutral soil reaction and low calcium carbonate content of these soils. Translocation of active manganese is indicated in the non-calcareous soils and appears to be associated with calcium carbonate mobilisation. With the other soil groups, manganese, both of active and total categories, appear to be stable on the surface horizon.

53. Improvement of Soil Fertility Through Earthworm.

BISHAN MANSINGH, Lucknow.

No systematic and organised effort has been made to investigate the possibilities of the supply of manure that may be available through earthworm culture though some sporadic attempts have been made in this direction by Dr. Bhal, Dr. Shrikhande and some others.

The earthworm brings up all the mineral requirements of the soil to the surface where they are needed most—these include phosphates, potash, nitrogen and lime and the trace elements as well.

It is suggested that investigations may be taken up by soil scientists to explore the possibilities of making phosphates, which are already present in the soil in unavailable form, available to plants through the agency of earthworms.

54. A New Clarificant and its Role in Gur Manufacture.

M. FAROOQUE, KAMTA PRASAD *and* K. L. KHANNA, Pusa, Bihar.

With a view to prepare a cheap, handy and effective clarificant for cane juice to be used in the open pan boiling process of sugar, a study of the chemical and physical properties of the aqueous extracts of sun flower, castor, groundnut, soyabean seeds and cane juice was undertaken. The results elucidated that the colloidal suspensions of soyabean extract possess the highest magnitude of positive charges on their surfaces and their iso-electric points lie between 6·4 to 7·2 pH. They are also richest in protein and P_2O_3 contents. The juice colloids on the other hand are negatively charged and their iso-electric points lie between 6·4 to 6·82. Hence the treatment of the juice with soyabean suspension provided a better means for effecting the coagulation and removal of the juice colloids. The reinforcement of the suspension with Na_2HPO_4 resulted in the development of a dark colour in juice whereas the addition of $CaH_4(PO_4)^2$ distinctly enhanced its clarifying property. When applied on a manufacturing scale 15-20 gms. of 97·5% of soyabean and 2·5% $CaH_4(PO_4)^2$ mixture per maund of juice yielded outstanding results. This product had an attractive colour, low colloids, low ash and low moisture absorbing capacity.

55. "Sugar yielding Palms and Palm sugar Industry in India".

B. C. JOSHI, Cuddalore, Madras.

The four principal sugar yielding varieties of Palms in India are :—

(1) Palmyrah (Borassus Flabelliformis).
(2) Date (Phoenix Sylvestris).
(3) Cocoanut (Cocos Nucifera).)
(4) Sago (Caryota Urens).

Palms are trees growing on non-agricultural soils needing no manuring or irrigation. Yield of juice varies from variety to variety and from season to season. On an average, 5 to 15 lbs. of juice can be obtained from each tree per day.

Palm juice called 'Neera' has been analysed and found to be a very nourishing and refreshing drink.

It has been established that palm gur is nutritious like sugarcane gur.

At present there are about nine crores of sugar yielding palms in India out of which about five crores are tappable and can yield one million tons of palm gur per year.

The development of Palm Gur Industry on cottage industry scale run on scientific lines in India has been initiated by the Government of India and a Research Station is being set up at Cuddalore N. T. (South Arcot). The station also imparts training to those interested in the industry.

56. On the improvement of productivity of eroded soils.

K. SENGUPTA *and* A. K. BHATTACHARYA, Suri, Birbhum.

The Mayurakshi Reservoir Project has undertaken reclamation of wastelands with a view to allot land to the cultivators who will be displaced due to submersion of their holdings consequent upon construction of the Messanjore dam. On most of these lands erosion has taken a heavy toll of the fertile top soil, as a result of which productivity has reached very low level. Experimental work was therefore undertaken to study the effect of fertiliser alone, green manure alone and green manure plus fertiliser on the productivity of the eroded soils.

Fertiliser alone—A field trial laid out in the usual randomised fashion with four replications leaving sufficiently wide border around each plot the net size of which was 1/50th acre. The fertiliser treatments consisted of eight combinations of ammonium sulphate and superphosphate in different doses.

Green manure alone—On sludged land sunhemp was plowed under at the flowering stage in the previous year.

Green manure plus fertiliser—On the sludged and green manured plot commercial fertiliser was applied. Aus paddy (Satika) was broadcast on all the plots.

It was found that yield of paddy obtained with green manure plus fertiliser is 20 mds. per acre while that with green manure alone is 10 mds. and the highest yield obtained by fertiliser alone is 15 mds. per acre. The yield of control plot is about 1 md. per acre.

57. Temperature resistance and Viability in Rice.

G. V. CHALAM, Cuttack.

Paddy spikelets and rice kernels in dry condition were subjected to temperatures from 42°C upto 95°C. The seeds were kept at the different temperatures till the lethal limits for the viability were reached.

It was found that paddy spikelets and kernels maintained their viability even after prolonged exposures to high temperatures.

Compared to other cereals rice seed has the greatest resistance to high temperatures among all the cereal crops so far investigated.

The relation between the moisture content of the seed and its resistance to temperature was investigated. It was found that the internal moisture content of the seed (remaining at the normal storage condition) had no relation with the resistance of the seed to high temperatures. Only the age of the seed appeared to have a bearing upon its resistance to temperature.

58. The Influence of Copper on the early growth of Rice Plant.

SHYAMANANDA PATTANAIK, Cuttack.

The influence of Cu on the early growth of rice plant was studied. Rice seedlings were grown in especially purified nutrient solution. The technique developed by Stout and Arnon was adopted for the purpose.

It was noted that (1) in the absence of added Cu, the plants were yellow in colour and there were rolling and drying out of the leaves as if they were suffering from severe draught. (2) When Cu was added in concentrations of 0·001 or 0·01 ppm, the plants were normal and the dry weight of sheet increased by more than three fold. (3) The optimum concentration of Cu in this experiment seemed to be around 0·001 and 0·01 ppm. (4) The concentrations of Cu—0·1 and 1 ppm—were toxic for the growth of rice plant and they inhibited chlorophyll synthesis.

59. Photoperiodic effect on Sugarcane.

C. THAKUR *and* N. S. NEGI, Pusa (Bihar).

Five varieties of sugarcane i.e. Co. 419, B.O. 27, Co. 313, B.O. 11 and B.O. 10 were subjected to continuous light-treatment for three months from August 8 to November 7, 1951. This treatment had depressing effect on the total number of leaves as well as total number of internodes in most of the varieties. It was further revealed as Purvis and Gregory postulated that a minimum number of leaves must be produced before initiation of flowering in sugarcane. The ratio of primordial leaves to green leaves was increased due to light save in case of Co. 313. The ratio of primordial to total number of leaves was found to be decreased in casually flowering varieties while it decreased in non-flowering varieties. But reverse was the case when ratio between developed and total internodes was considered. The sucrose content of 4 varieties i.e. Co. 313, B.O. 27, B.O. 11 and B.O. 10 under continuous light-treatment decreased. But in case of Co. 419, a wonder cane of South India and most suited to tropical climate, there was no change in sucrose content due to light. In all aspects of studies there was observed a distinct differential varietal response to photoperiods.

60. Utilization of Waste Fruits for wine making.

D. S. JOHAR *and* J. C. ANAND, Mysore.

India is spending enormous sums of money (in the neighbourhood of Rs. 1·5 crores) for importing good quality fruit wines to cater the needs of her civil, military and pharmaceutical requirements. Coorg oranges, which are famous for sugar-acid blends give beautiful orange wine after amelioration with extra sugar. Experiments were conducted with Monsoon oranges more than 60% of which at present rot and perish in the orchards on account of heavy rains at the harvesting season. This entire wastage of crop can be utilised in the preparation of orange wine and orange brandy.

Experiments conducted with other waste fruits of this region like Coorg plum and cashew apple reveals the scope of good quality wines from these fruits.

The data collected throws light on the enormous potentialities for the preparation of good quality fruit wines from these fruits at a very cheap cost, less than one half of the imported price of similar foreign wines. Coorg plum and cashew apple wines hold a promising future for export to the foreign markets.

61. Preservation of Mangoes (*mangifera indica*) at Low Temperature for Chutneys.

J. C. ANAND *and* D. S. JOHAR, Mysore.

Mango Chutney is prepared from peeled raw mango slices usually of seedling variety. Methods in vogue for the preservation of these slices in the industry comprise of keeping these slices in vats either with powder salt or salt solution. During storage, slices become a bit soft and lose some valuable minerals during salting. To overcome these defects varieties of green mangoes for making chutneys were stored at seven different temperatures ranging from 32—55°F. It was observed that non-fibrous variety could store well at 40—43°F for a maximum period of 40 days and best suited for preparation of chutneys. During storage different types of rots attacking the fruits were also studied.

62. (*a*) Cold Storage of Potatoes.

P. B. MATHUR, K. KIRPAL SINGH *and* N. S. KAPUR, Mysore.

In the cold storage of potato tubers two considerations are of major importance (1) Maintenance of the natural quality for table purposes and (2) retention of vigour in "Seed" potatoes so that there is no reduction in the yield on subsequent planting.

After 7½ months of storage at 36·5°F the sound potatoes lost 12·44% in weight whereas the loss in weight for damaged potatoes during the same period and at the temperature was 21·25%. This clearly demonstrates the importance of curing potatoes preparatory to their cold storage. Research work at this Institute has also shown that curing of potatoes at 100-104°F for 16 hours, preparatory to cold storage, reduces considerably the loses in weight. Losses due to disease were negligible in the temperature range 33·5°-48·5°F. Treatment with 1% potassium permanganate solution did not improve the keeping quality of potatoes to any appreciable extent. At 33·5°F there was a considerable accumulation both of sucrose and reducing sugars. The optimum conditions for the Cold Storage of potatoes are a temperature of 36·5°F and a R.H. of 85-90%.

62. (*b*) Cold Storage of Mangoes.

P. B. MATHUR, K. KIRPAL SINGH *and* N. S. KAPUR, Mysore.

Mango (*Mangifera indica*) is an easily perishable fruit and strict observation of certain conditions is essential for its successful storage.

From the point of view of minimum physiological losses in weight (i.e., losses due to transpiration and respiration) during storage, 42-45°F appears to be the most suitable temperature for all the three varieties investigated. There was a progressive decrease in total acidity and the total ascorbic acid contents during storage in all the varieties and all the storage temperatures under investigation. Raspuri mangoes can be stored for a maximum period of 42 days at a temperature of 42-45°F and a R.H. of 85-90% in a green condition. Badami mangoes can be stored for a maximum period of 28 days in good condition at a temperature of 47-50°F and a R.H. of 85-90%. At 42-45°F and R.H. 85-90% seedling mangoes were still fresh and green after 42 days of storage and could be used for the making of pickles.

Raspuri mangoes stored at 42-45°F for 28 days could be ripened uniformly at room temperature (73-79°F). Freshly-picked Badami mangoes can be ripened satisfactorily at 62-65°F in 15 days.

Anthracnose was the main cause of the end of the storage life at 47-50°F and 52-55°F. At temperatures below 42°F low temperature injury was evident in all the cases.

62 (*c*). Cold Storage of Cauliflowers.

K. KIRPAL SINGH, N. S. KAPUR *and* P. B. MATHUR, Mysore.

For successful storage of cauliflowers it is not only necessary to prevent wastage due to fungus diseases but also to arrest the maturation of the heads.

For this investigation Varma's Early Snowball variety of cauliflower, grown at the Municipal Sewage Farm, Mysore was used. A temperature of 33·5°F and a R.H. of 85-90% are recommended as the optimum conditions for the cold storage of Varma's Early Snowball variety of cauliflowers. Waxing the cut stem ends of cauliflowers resulted in an improvement of the keeping quality. The storage life was found to be 6-8 weeks. The physiological losses in weight were found to be smaller in compact heads as compared to loose heads. The loss of vitamin C under the optimum conditions of storage was about 4%.

62 (*d*). Cold Storage of Bananas.

K. Kirpal Singh, N. S. Kapur *and* P. B. Mathur, Mysore.

Banana plants produce bunches all the year round, thus obviating the necessity of long-term storage. However, because of the highly perishable nature of the fruit refrigeration is necessary for long-distance transportation as also to facilitate marketing.

Cavendish variety of banana was stored at various temperatures to determine the optimum cold storage conditions for its storage. Two stages of maturity were used, namely, "A" and "B". These two stages were defined as follows: Stage "A"—Fruits green and hard and difficult to peel and Stage "B"—Fruits turning yellow, yielding to pressure but not fully ripe.

A temperature of 52-55°F and a R.H. of 85-90% are recommended as the optimum conditions for the cold storage of cavendish variety of banana. The storage life of Stage "A" is longer as compared to Stage "B". During ripening of bananas there is a decrease in the percentage of sucrose and an increase in the percentage of reducing sugars.

62 (*e*). Cold Storage of Brinjals.

K. Kirpal Singh, N. S. Kapur *and* P. B. Mathur, Mysore.

Because of the highly perishable nature of brinjals as also the high yields obtained with this vegetable crop, the fluctuations in the retail prices of this commodity are tremendous. If during the glut periods, brinjals could be cold stored for 3-4 weeks, it would certainly stabilize the retail prices for the benefit of the vegetable growers and would result in reducing the considerable losses that occur between the harvesting and the consumption of the brinjals.

In the present investigation "Eerangeri" variety of brinjal, grown at Mysore, was used. Two sizes (45-50 gms. and 14-18 gms.) of brinjals were stored at various temperatures ranging between 32°F and 60°F. Large-sized (45-50 gms.) brinjals can be stored satisfactorily at 47-50°F and a R.H. of 87-90% for 4 weeks. After 4 weeks' storage at 47-50°F the large-sized brinjals were cooked and a very satisfactory product was obtained.

63. Specialisation in Pathogenicity in *Helminthosporium oryzae, and Piricularia oryzae.*

S. Y. Padmanabhan, Cuttack.

In order to know whether varieties of rice found resistant to blast and helminthosporium diseases of rice in artificial infection studies against local isolates of the fungi at Cuttack would behave similarly in other parts of India, infection experiments were conducted with a few isolates of the rice pathogens, *Helminthosporium oryzae* B. de Haan (*Ophiobolous miyabeanus* Ito et Kuribiyashi), and *Piricularia oryzae*, Br. et. Cav., obtained from different parts of India on some selected rice varieties. Four isolates of *H. oryzae*, 2 from Cuttack, and one each from Uttar Pradesh and Madras were tested on the rice varieties, CH.60, T.141, PTB.10, SLO.4, SLO.3, PB.9 and DCA.2. Five isolates of *P. oryzae*, 2 from Cuttack, 2 from Madras, Wyanad and Coimbatore, and one from Indian Agricultural Research Institute, Delhi (Kashmir) were tested on nine rice varieties, Tx_1, Tx_2, Tx_3, Tx_4, Tx_5, CO.13, ASD.1, BAM.3 and G.E.B.24. In the case of *H. oryzae*, DCA.2 remained very susceptible to all the four isolates of the fungus while the variety, CH.60 was resistant to all the isolates. There were slight differences in the reactions of the other varieties. Likewise in the case of the *P. oryzae* also, the variety, Tx_1, remained very resistant to all the five isolates of the fungus, while CO.13 was very susceptible, followed closely by ASD.1, while the reactions of the other varieties tested were intermediate between these classes. But there was no evidence to conclude that there was any specialisation in the pathogenicity of the isolates on the basis of the reactions of the varieties tested.

64. Bionomics and Control of Deccan Wingless Grasshopper (*Colemania Sphenaroides*).

MOHD. QADIRUDDIN KHAN, Hyderabad-Dn.

Colemania sphenaroides is a major pest of Jowar, Bajra and Kangni and to lesser extent of Groundnut in Hyderabad State. Its activity is restricted only to three taluqs of the district of Raichur which is surrounded on the North by the river Kristna, and in the South by Tungabhadra. The pest is not found on the other side of the river in the districts of Mahbubnagar and Gulbarga.

The pest is active from July to September. *Kharif* crops suffer most in July and August. In September when the grain formation is taking place the pest attacks grains also. About a dozen adults are not uncommon on every earhead, resulting in very little grain formation.

Hoppers hatch out soon after the first monsoon showers and start feeding on young crops. By end of September the final instars predominate and copulation followed by egg laying is noticed in the field. In light soils, the grasshoppers oviposit in the normal manner by thrusting their abdomen into the ground, whereas in the black soils (which start showing cracks by the middle of September) the eggs are conveniently laid in such cracks.

In the early stages the grasshopper is controlled even by 5% BHC dust; when the pest is in the older instars, it is necessary to dust 10% BHC at the rate of 20-25 lbs. per acre, when crop is young. However even 10% BHC is not effective at dosages upto 40 lbs. per acre if the pest is full grown. This happens in September when day temperatures are high and humidity low.

Section XI, Physiology.

96. Muscular Efficiency and Menstruation.

S. PARVATHI DEVI, Madras.

This investigation was undertaken on certain groups of women students with a view to find out whether there is any alteration in their capacity for muscular work during menstruation.

A number of women students have been investigated under certain standard conditions, viz.:

(*a*) Age range 20 to 21 years.
(*b*) Physical build—of fair uniformity.
(*c*) Height 5′ to 5′ 2″.
(*d*) Weight 95 to 105 lbs.
(*e*) Time of performance of experiment fixed.
(*f*) Instrument used—Mosso's Ergograph well standardised and the weight used fixed in all cases under investigation.
(*g*) Rate of contraction fixed at 50 per minute tuned to a metronome.

Ergographic tracings were recorded under the aforesaid standard conditions at two phases of the month—the mid-menstrual interval and the menstrual phase. From the graphs obtained, the work done by the flexor muscle of the middle finger used was calculated in each instance.

The results obtained have been tabulated and plotted graphically and the percentage of reduction in muscular efficiency during menstruation calculated. It is observed that the work done by the muscle during the menstrual phase in women is significantly reduced in all cases as compared to the work performed during the mid-menstrual interval. The reduction ranged between 24 and 31 per cent. These observations therefore furnish some evidence to support the probable conclusion that during menstruation, there might be a decrease of muscular efficiency in women. The question whether a menotoxin is the cause or whether any other metabolic or neuro-endocrine fact is responsible for the earlier onset of fatigue during menstruation requires further investigation.

97. Distribution of Blood Groups among the Medical Students in Madras.

E. A. MICHAEL *and* M. M. GURUSWAMI, Madras.

This paper is the result of work done during 1943-44 in the Department of Physiology, Madras Medical College. The medical students examined in this test present a fair cross-section of the population in South India, with some from areas scattered around it. Blood grouping was done according to the standard macroscopic technic. An attempt has been made to present the data obtained according to sex, community, language, diet, etc. A comparison with the data given by a number of authors is presented concurrently. Variations, if any, in the findings are pointed out and discussed.

98. Effect of Celastrus Paniculata Seeds (Wild) on the body tissues and brain.

N. N. Das, Calcutta.

The seeds of Celastrus Paniculata (Vernacular Malcaguni) have been in repute in the Ayurveda as a stimulating drug which increases the intellectual powers (Buddhi) and sharpening the memory (Smriti Sakti). The oil of the seeds is mainly responsible for this property. It is said to have many other properties in the cure of rheumatism, gout, paralysis, beri beri, etc., and is an aphrodisiac.

The oil extracted from the seeds by Shoxlet method was used for the experiment. The watery solution of the oil in very high dilution like 1 : 100,000 to 1 : 1,000 was used, in mammalian and frog heart perfusion. The dilution 1 : 10,000 was the sub-minimal dose to stimulate the heart in a depressed condition. The concentrated solution of 1 : 100 does not produce any toxic effect. The involuntary muscles like Uterus and Intestine respond as a stimulant in 1 in 10,000. The clinical trial of the memory test was also being conducted, which shows some promising results. The brain wave changes are being recorded. This is a preliminary report.

99. The electro-encephalogram of sleep in normal and psychotic conditions.

N. N. Das, Calcutta.

Records of brain wave were taken with the help of Grass EEG machine from normal and psychotic subjects during waking and sleep. The wave form, voltage and the number of spikes in 20 seconds of recording were compared. The sleep cycle changes from waking to sleep were also noted. It is very difficult to co-relate with the presence or absence of psychosis. Subjects with psychiatric disorders like these, in psychomotor epilepsy (i.e. assultive, paranoid, Schizophrenics) were recorded awake and asleep. In normal controls in comparison with psychotic subjects seizure discharges, have focal or diffuse slow and fast activity. The EEG disorder, does not co-relate highly of psychosis. But in cases of severe psychiatric symptoms associated with psychomotor epilepsy, the anterior temporal lobe shows some abnormalities.

100. Adrenochrome—Physiological Investigations—I.

D. V. S. Reddy, G. I. George *and* V. Srinivasan, Madras.

In a few preliminary experiments with dogs (anaesthetised with paraldehyde), the animals were found to stand intravenous doses upto 15 mg. per kilogram body weight without any immediate toxic effects. In most of the experiments, there was no appreciable alterations in blood pressure and cardiac rate. When adrenochrome was perfused through isolated heart of kitten, there was lowering of the heart rate and of its amplitude, suggesting a parasympathomimetic action.

The effect of adrenochrome on isolated segments of intestine of kitten was studied by suspending the segment in Ringer-Dale solution in a specially designed apparatus and recording the movements. The effect was compared with those obtained with acetylcholine and adrenaline. With dilute solutions of adrenaline (1 in 10,00,000) in the bath, the relaxation of the muscle during the first three minutes was followed by an acetylcholine like response. With a solution of adrenochrome (1 in 1,00,000), the acetylcholine like response was obtained within 30 to 45 seconds, without the preliminary relaxation noticed with adrenaline. If along with adrenochrome choline chloride, hexose-monophosphate or sodium pyruvate was added to the bath solution, the acetylcholine like response was more marked. It was also noticed that the addition of acetylcholine along with adrenochrome led to greater increase in the tone of the muscle and the activity also lasted longer than with either of the compounds added separately, thus resembling the effect of esserine when added along with acetylcholine. The bath solution in which the intestinal segment showed an acetylcholine like effect after the addition of adrenochrome gave an acetylcholine like response when perfused through isolated heart of kitten.

These experiments suggest that the acetylcholine like effect seen at the end of three minutes with adrenaline is due to the formation of acetylcholine in the intestinal wall and the compound responsible for that formation is adrenochrome, derived from the oxidation of adrenaline. The fact that adrenochrome is structurally related to rubresserine (a Physostigmine breakdown product) which also has an inhibitory action on choline-esterase activity, suggests that adrenochrome brings about this acetylcholine like effect, not only by the production of acetylcholine in the walls of the intestines but also by inhibition of choline-esterase activity.

Even though such parasympathomimetic actions are seen in isolated intestines and isolated heart of mammals, such actions are not marked in intact animals, probably due to either the rapidity of destruction of adrenochrome in the body or due to other compensatory mechanisms neutralising its effect.

101. Effect of fever on the thyroid glands of rabbits.

T. P. SINHA, Patna.

The study was made on the thyroid glands of rabbits after inducing fever by physical and chemical means.

The changes in the thyroid follicles were of varying degrees depending on the intensity and duration of fever. These changes could correspond with the changes found in the non-functioning type of thyroid.

102. Physiological studies on the blood of domestic animals, Part IX—Blood haematology of sheep on different levels of iron intake.

N. D. KEHAR *and* V. N. MURTY, Izatnagar.

The influence of four levels of iron intake, on hemoglobin, corpuscular volume, Red and white corpuscular counts, and the mean corpuscular values—M.C.V., M.C.H,. and M.C.H.C.—were studied for a period of six months. The animals, on the basal diet, with an average intake of 118·8 ± 10·02 mg. of total iron, or 47·9 ± 4·04 mg. of available iron, though sub-adequate, as was evidenced by the metabolic data, maintained their initial values for a period of six months. The supplementation of 10, 20, and 50 mg. of iron, as ferrous ammonium sulphate, to the basal ration, recorded highly significant increases in hemoglobin, mean corpuscular hemoglobin, and the mean corpuscular hemoglobin concentration, as compared to the control group, on sub-adequate iron intake, but without any significant differences within the three supplemented groups. The supplementation of iron to the basal ration was without any significant effect on the red and white corpuscular counts, corpuscular volume, and the mean corpuscular volume. The animals on sub-adequate iron intake showed a tendency of developing a hypochromic anemia, characteristic of iron deficiency.

103. Physiological studies on the Blood of Domestic Animals

Part X.—Blood iron and copper in relation to different levels of iron intake.

N. D. KEHAR *and* V. N. MURTY, Izatnagar.

The effect of four different levels of iron intake, on the blood iron, easily split off iron, and copper, and also on serum iron of sheep was investigated for a period of six months. The control group was maintained on a sub-adequate iron intake, and the other three groups were daily supplemented with 10, 20, and 50 mg. of iron, as ferrous ammonium sulphate.

The results on statistical analysis indicated that the changes in the blood iron and serum iron were highly significant not only from period to period, but also between the different groups. No significant variations were noticed between the different groups in the easily split off blood iron. The blood copper exhibited an insignificant inverse relation within the limits of iron intake studied over a limited period of six months.

104. Physiological studies on the Blood of Domestic Animals. Part XI—Blood composition of sheep in relation to different levels of iron intake.

N. D. KEHAR *and* V. N. MURTY, Izatnagar.

The changes in the concentration of sugar and inorganic phosphorus in blood, and of calcium, magnesium, and protein in the blood serum of sheep maintained on four different levels of iron, for a period of six months, were investigated. The average daily intake of 118 ± 10·02 to 165·9 ± 2·43 mg. of total iron or of 47·9 ± 4·04 to 96·9 ± 0·92 mg. of available iron did not exercise any significant effect on any of the constituents studied except the blood inorganic phosphorus, which exhibited a highly significant inverse relation with the intake of iron, within the limits of this investigation.

105. Animal Nutrition Survey: Part I—The Chemical Composition of Summer Crops.

N. D. KEHAR, V. N. MURTY, *and* L. V. L. N. SASTRY, Izatnagar.

The effect of progressive maturity on the variations in the chemical composition of Andropogan Sorghum (jawar), Pennisitum typhoideum (Bajra), Phaseolus mungo (urd), Phaseolus radialus (moong), Phaseolus aconitifolius Jacq (moth), Sesamum Indicum (til), Cajanus indicus (arhar), Arachis hypogea (ground nut), Vigna catjung Endl (cow pea), were investigated.

Representative samples of the crops collected under identical conditions from two adjoining villages of U.P.—Bhoora and Pirbhoora—one of which (Pirbhoora) is irrigated by a distributory of the Sarda canal, were analysed at monthly intervals, from the date of sowing till they were dead ripe, for the organic and inorganic nutrients.

The crude protein, soluble ash, phosphorus, and calcium (except in the case of cow pea, where the calcium increased) decreased, while the crude fibre increased with the progressive growth of all the crops studied from both the villages.

106. Animal Nutrition Survey: Part II—The chemical composition of pastures.

N. D. KEHAR, V. N. MURTY *and* L. V. L. N. SASTRY, Izatnagar.

The changes in the chemical composition of the composite pasture samples from five different areas of an irrigated village (Pir Bhoora) and also from three different areas of a non-irrigated village (Bhoora) were studied, at monthly intervals for a period of one year. The range and the mean of the different constituents have been recorded.

107. Chemical Composition and Nutritive Value of Musel (Iscilema Laxum) Grass Hay at the pre-flowering stage.

K. CHANDRA, Izatnagar.

Musel is a tufted perenniel with a stout, short, creeping root-stock. It grows mostly in damp situations.

The percentage composition of the hay, on dry basis, was found to be:—crude protein 6·48, ether extract 1·60, crude fibre 38·30, nitrogen-free extract 42·54, total ash 11·08, calcium (Ca) 0·58 and phosphorus (P) 0·51.

The nutritive value of the Musel grass was determined by running a metabolism trial on Kumauni bullocks. The animals were fed on the hay supplemented with rape cake, to make up the digestible protein and dry matter requirements. The average percentage digestibilities of crude protein, ether extract, crude fibre and nitrogen-free extract were found to be 53·19, 35·01, 73·16 and 60·59.

The digestible crude protein, total digestible nutrients and starch equivalent values in lbs. per 100 lbs. of the dry hay were found to be 3·45, 56·88 and 35·11 respectively. The animal recorded positive balances for nitrogen, calcium and phosphorus and maintained body-weight throughout the experimental period.

Musel grass at the pre-flowering stage of growth is relished by the animals fairly well and they consumed 836·06 lbs. of it, on an average per 100 lbs. body weight.

It appears from the above that Musel grass at the pre-flowering stage of growth constitutes a suitable roughage.

108. Effect of induced Hypothyroidism on the fructose content of seminal vesicles and weight and Histology of certain Glands.

A. ROY *and* J. S. RAWAT, Mathura.

In order to study certain metabolic changes induced by hypothyroidism and its effect on other glands involved in metabolic processes, rats of same weight (134 g.), and sex were selected. These were divided into two groups; one set of rats were daily given thiourea mixed in their food to induce hypothyroidism. Pair feeding was resorted to, to eliminate the influence of food on growth, reproduction and metabolic processes. Thiourea was fed for a period of 70 days. The average thiourea consumed was approximately 18 mg/rat/day. The animals were weighed twice every week. At the end of the experimental period the animals were sacrificed and the following observations were made :—(1) Final body weight of the control (C), and experimental (E) groups were 171 g and 126 g respectively; the difference in the body weight was statistically highly significant. (2) The weights in mg of thyroid, seminal vesicles and adrenal glands, (fresh and dissected clear of extraneous tissues), of both the groups were: Thyroid, C, $10{\cdot}7 \pm 0{\cdot}82$, E, $33{\cdot}4 \pm 2{\cdot}09$; Adrenals, C, $21{\cdot}6 \pm 1{\cdot}0$, E, $14{\cdot}4 \pm 1{\cdot}07$; Seminal Vesicles, C, $382{\cdot}2 \pm 19{\cdot}6$, E, $128{\cdot}2 \pm 21{\cdot}8$; these differences in weights were again statistically highly significant. (3) Moisture content of the adrenal gland, C, $64{\cdot}98\% \pm 1{\cdot}7$, E, $69{\cdot}70\% \pm 1{\cdot}6$. The difference in the moisture content was statistically significant. (4) Fructose content of the seminal vesicles, C, 0·57 mg/g, E, nil or in trace. (5) Alkaline phosphatase activity, estimated histochemically, revealed a spectacular activity in the control group, and practically nil in the experimental group. (6) Histological examination of the liver showed extensive degenerative changes suggestive of an acute fatty infiltration of the liver; there was marked hypertrophy of the thyroid gland with complete absence of the colloid matter.

109. Phrynoderma.

N. P. BENAWARI *and* R. B. MATHUR, Gwalior.

The problem of Phrynoderma has been discussed in view of the result of studies based on a survey of the assessment of nutritional status of 1127 subjects (mostly children) in Gwalior and the diet surveys of 30 representative families in the same area.

Close correlation has been found between the incidence of this condition and other signs and symptoms of vitamin A deficiency. Also the diet of average people in this part has been found to be deficient in vitamin A and its precursors.

It has been shown that while vitamin A deficiency is an important causative factor, it alone is not entirely responsible for this condition. Possible roles of fats and essential fatty acids, of vitamins of the B group and of proteins have been suggested.

110. Reflex control of temperature in dogs.

SURENDRA KUMAR, Lucknow.

Dogs which do not possess sweat glands for temperature regulation possess a special reflex mechanism for this purpose. This mechanism consists of a reflex increase in respiration on opening the mouth only when its temperature is raised, in the majority beyond 41°C, although it has been observed at as low a temperature as 37°C; and that it again starts disappearing at about 42°C when perhaps its rate already reached its maximum and could not be raised further on opening the mouth. Besides, this reflex could not be elicited when the anaesthesia was too deep or the health of the dog was very poor. It has been found that the lingual, superior and the recurrent laryngeal nerves possess the fibres carrying the extra-pulmonary temperature reflexes. There is a strong suggestion that the fibres carrying these reflexes arise mainly from the laryngeal tissues—chiefly from the muscles round about, since along with the reflex increase in respiration the larynx also moved simultaneously and that immobilisation of the larynx immediately slowed the respiration even when the mouth was kept open. Majority of these experiments show that these extrapulmonary fibres travel ultimately through the vagus, although some have shown that some may travel independently of vagus.

As contrasted to reflex quickening of respiration, reflex slowing at high temperatures was also observed on applying deep pressures at places more abundant towards the anterior end than towards the posterior end of the dog. It is suggested that the reflex slowing may be nature's mechanism for the conservation of carbon-dioxide when its stores are washed away beyond the danger limit in over ventilation due to heat, but it is not yet certain as to how under natural conditions this reflex slowing is effected as contrasted to reflex quickening of respiration on opening the mouth which under natural conditions is brought about by the action of gravity assisted by decrease in tone of muscles by heat.

This special mechanism does not seem to be a peculiarity of furry animals as it was not found in rabbits.

These experiments strongly suggest that this reflex control of respiration is not meant so much for the regulation of respiration as it is for the regulation of temperature.

111. Plasma—A source of water in emergency.

SURENDRA KUMAR, Lucknow.

It is already known that in various infective conditions globulins increase and the albumin decreases in plasma. The present work was undertaken to find out if along with infection temperature has a similar effect. With this end in view total plasma proteins and albumin were separately determined by the microchemical Nesslerization method of King, in various 75 human cases of fever. For the sake of comparison 50 normal persons were also investigated on similar lines.

In normal cases the average total plasma proteins were found to be 6·75 gm.%, and the average plasma albumin and globulins were found to 4·00 gm. and 2·75 gm.% respectively. In the fever cases on the other hand total plasma proteins decreased to 6·69 gm.% and the albumin fell to 3·00 gm.%, while the globulins increased to 3·69 gm.%. The important point observed was that the increase in globulins was found in most cases to be proportional to the rise in temperature. It is suggested that the biological necessity at such times is to get rid of the toxins and to bring down the temperature to normal, and for both these functions water is required. Since the albumins decrease in fever and that the globulins have a higher molecular weight than the albumin, the plasma molecular concentration falls during fever and this it is suggested releases water. The importance of this water is great because it is released in the blood direct and therefore can be more easily utilised for the excretion of toxins and temperature regulation.

112. Intestinal movements and carotid sinus.

SANJIVA RAO K. *and* REDDY, D.V.S., Madras

A study of the recent increasing literature on the carotid sinus shows clearly that while considerable attention has been paid to its influence on cardiovascular and respiratory systems, very little work has been attempted to investigate its effects on the alimentary system. The present work was therefore undertaken to ascertain whether changes of pressure within the carotid sinus have any effect on intestinal movements.

Experiments were conducted on dogs under paraldehyde anaesthesia and effects of varying the pressure inside the carotid sinus on intestinal movements and blood pressure were then observed. On increasing the pressure inside the carotid sinus, the systemic blood pressure, recorded from the femoral artery, showed an immediate fall and after a few seconds, the intestinal record, showed an increase in the tone and contractions. On decreasing the pressure inside the sinus, a slight rise of systemic blood pressure was noticed, but the intestinal record did not show any marked change. These responses were compared with those obtained by injection of adrenalin and acetylcholine into femoral vein.

The effects on blood pressure and intestine as noted above may be due to liberation of acetylcholine and adrenaline according to the variation of pressure inside the sinus. This effect conforms to the regular finding that stimulation of carotid sinus nerve endings results in reflex inhibition of vasomotor centre, with concurrent stimulation of vasodilator centre, bringing about liberation of acetylcholine, which is reflected in increased tone and contraction of intestinal musculature. Further work on these lines is in progress.

Section XII, Psychology and Educational Science.

21. Quickness and Intelligence.

T. P. Lele, Baroda.

The present study was undertaken to find the relation between quickness and intelligence. The material used for this study was a short analogy test. The test was given to a group of 124 children. The group had an I.Q. range of 48 I.Q. points. First the children were given the test with a time limit and then they were asked to score the test without time limit.

Correlations between (1) timed scores and I.Q., (2) untimed scores and I.Q. and (3) between timed and untimed scores were calculated. The respective correlations are +0·681, +0·710 and +0·592. The higher correlation in the case of untimed scores indicates that they are more dependable than the timed scores. If however instead of considering all children we consider the middle group having a range of 20 I. Q. points the correlation coefficient between timed and untimed scores becomes 0·376. The comparison of the correlation with that of the entire group may possibly point to the fact that as the range of I. Q. becomes smaller the relation between speed and ability decreases. This means that the speed of reaction to intelligence test items bears a smaller relation to intelligence when a group of children with approximately equal abilities is considered.

22. Measurement of Understanding in Physics.

D. S. Nigam, Delhi.

The paper contains a brief account of the construction of a test of understanding in physics for pupils who completed the group B course of physics for the higher secondary examination 1952 of the Board of Higher Secondary Education, State of Delhi. The test can, however, be used for pupils of most of the present schools of higher secondary education in this country.

Directions for constructing this test were mostly derived from the Forty-fifth Year Book Part I. Measurement of understanding of the National Society for the study of Education, U.S.A.

The test contains 12 exercises split up into 82 items in all. It is highly representative of the various fields of the physics course usually found for higher secondary education in the country. Validity of the test as a measure of understanding and reliability were approximately estimated on the basis of scores obtained by pupils in the trying out process of the test. The coefficients work out to be ·660 ± ·059 and ·701 ± ·02 respectively.

Norms are yet to be prepared. *Provisional* norms for higher secondary schools of Delhi are given in the form of percentile scores.

An account of comparative study of achievement in understanding of physics in the schools of Delhi is also given.

23. Rumours as a Factor in Public Opinion during Election.

Durganand Sinha, Patna.

Of the many devices which are employed in shaping public opinion in a political campaign, rumour plays an important part.

Two sorts of rumours are generally to be noted—deliberately *planted* and *spontaneous*. Though it is difficult to determine which rumour is deliberate and which is spontaneous, in their ultimate analysis both are very similar. The psychological factor responsible for the vitality of both and their acceptance is the same, *viz.*, they provide a structure to the confused situation. As a matter of fact, rumours became especially rampant near the date of polling, and when the conflict is at its highest, and the prospect of various candidates seem to be all too uncertain.

The author lists the main varieties of rumours during the election, and indicates their purpose. Rumours seem to have a dual role—they *confuse* and at the same time *remove confusion*. It is also contended that rumours are a sort of "social barometer" indicating the attitude of the group.

24. A Study of the Problems of Production and Morale in an Industry in Bihar.

Promde K. Suri, Patna.

The opinion of different officers : Departmental heads, Sectional heads, Supervisory staff, Labourers, and Labour leaders were studied on different problems of this industry. Methods employed were (I) Questionaire and (II) Open-end-interview questionaire consists of 3 parts :—1st part like Likerts 5 pt. scale, 2nd 3 pt. scale and 3rd of questions and blanks. Special code was devised for coding interviews. The two methods were also compared and correlation obtained was 90. Subjects were 50 who were interviewed and 20 who had filled in the questionaire. In some departments Motion and Time study was also made, which has saved lot of wastage of money and labour. The research was conducted with the co-operation of the Government of Bihar and the management. In the results extent of opinion held by different type of personale with respect to question items are shown in the form of percentage figures.

25. Validity of Photographs in Determining Personality Traits.

A. Jamil Qadri, Aligarh.

In my study on the 'Validity of Photographs in Determining Personality Traits' I have used a specialized technique to determine as to how far we can rely upon character judgments made by the examination of photographs. Traits of character such as honesty, courage, sociability, etc. have been designed on a printed form so as to make the task easier and more scientific. Ten photographs of persons were obtained for this experiment and were graded by close acquaintances in fine traits selected for this purpose. They made their judgment on the basis of three point scale as high, indifferent and low. These judgments of the close acquaintance served as the objective criteria. The scores made by ten subjects employed for this experiment were compared with the objective criteria.

The data so obtained from this experiment shows that there is some correlation between the subjects' scores and the outside criterion. But in some cases the correlation is very poor. This method can be further modified in different ways. The development of selection procedures on a scientific basis makes it necessary to evaluate such methods and techniques on sound grounds.

Photographs are variously used as a basis for judging personality traits. But psychologists have not as yet paid sufficient attention to these procedures and methods which are employed to select the Industrial Personnel Personal Department entrusted with this responsibility must take every precaution to evaluate such methods and techniques on scientific and pure psychological grounds.

The results which I have drawn from this experiment are not much satisfactory. But psychologists in our country need pay due attention to these problems and investigate them thoroughly.

26. A Psychological Study of the Social Values of some aspects of Human conduct on the basis of opinions of the adult college students.

K. C. Mukherji *and* Asoke Kumar Bose, Calcutta.

Opinions of the adult college students were collected from their replies to the questionaire presented to them. The questionaire was framed in a way to cover different aspects of human conduct such as sexual relationship, murder, homicide, stealing, lying, etc. Supernatural sanction in judgment of values, nature of goodness and hierarchy of crimes were also indicated in their opinions.

The differences of opinion of the male and female students are particularly made and some observations made.

Section XIII, Engineering and Metallurgy.

38. A Suggested Rationalisation of the 'difference thermal Curve' technique and an enquiry into its performance.

K. V. Rathnam, Hyderabad-Deccan.

In this paper the author describes a new technique adopted by him in a study of the "difference thermal curves" of ferrous and non-ferrous alloys. Roberts-Austin's method wherein he used a neutral body like platinum near his specimens involves difficulties. The author avoids the use of such neutral bodies by keeping his specimen in suitable enclosures. The essential requisites for such enclosures are described. Various insulators for use between the specimen and enclosure were tested and Kieselguhr was found to be the best. In all cases, the cooling curves gave clearer indications of the critical points than the heating curves. In general non-ferrous alloys gave better results than steel specimens. Results comparable with those obtained using "Inverse rate Curve" technique were obtained.

39. Study of the stress-strain and shear characteristics of Soils by Triaxial Compression Tests.

S. C. **Barai**, Poona.

Stress-strain and shear characteristics of three typical Deccan Soils have been studied on specimens remoulded under different conditions of density and moisture content by the Triaxial Compression tests. Stress-strain curves were found to differ depending upon the soil, moisture content and density of structure of the specimens and the minor principal stresses under which the tests were performed. Both cohesion and angle of internal friction were found to decrease with increase in moisture content. With increase in density of structure of the soil specimen cohesion was found to increase but the angle of internal friction was found not to vary markedly.

40. Hydrometeorology of the Mayurakshi Catchment.

S. K. **Pramanik** *and* K. N. **Rao**, Poona.

Hydrometeorological studies of the different river catchments have assumed considerable importance in view of the number of river valley projects in the country. The authors have carried out detailed hydrometeorological studies of the Mahanadi, Koyna and Damodar Catchments. This paper contains a similar study of the Mayurakshi Catchment. The main results are given below:

(1) The main surface wind direction over the Catchment area during the monsoon months is between NE and E or calm.

(2) The mean rainfall (June to October) of the Catchment is 45·88″.

(3) On an average about 82% of the annual rainfall occurs during the period June to October.

(4) The variability of rainfall is about 30% during July and August and over 40% in the other three months. The variability for the monsoon period as a whole is 19%.

(5) The distribution of June to October rainfall is normal.

(6) The normal date of onset of the monsoon is about the end of the second week of June.

(7) The mean of the rainfall of the stations Naya Dumka, Deogarh, Saroth and Nunihat/Jarmundi is taken to represent the mean rainfall of Catchment.

(8) There has been no significant change in the June to October rainfall of catchment since 1891 and there is no linear or quadratic trend.

(9) Frequency distribution of daily rainfall for each day during 1891 to 1950 and the months June to October has been computed.

(10) Frequency distribution of one to seven days have been prepared.

(11) The highest recorded rainfall in one to seven days is as follows:

One day	7·23″	Five days	14·74″
Two days	10·98″	Six days	14·93″
Three days	12·24″	Seven days	16·10″
Four days	13·84″		

These values were recorded in the spell of heavy rainfall during the period 9th to 16th August, 1935.

(12) The maximum rainfall which may occur in the Catchment in one to five days is as follows:

One day	11·5″	Four days	21·0″
Two days	16·0″	Five days	22·0″
Three days	19·0″		

(13) A comparative study has been made between the Damodar and Mayurakshi Catchments. Rainfall between the two catchments is significantly and highly correlated.

(14) The monthly value of discharge is significantly correlated with the rainfall in the Catchment.

41. Status of Sugar-cane Wax production as a part of Sugar Industry.

K. V. KUMARANADA RAO *and* M. NARASINGA RAO, Waltair.

A review of the investigations on sugar-cane wax, its chemical constitution, extraction from press-cake, refining and utilization and design of the extraction units on pilot plant and large scale is presented. It is pointed out that cane wax production should be an essential part of cane sugar industry in India.

42. Patents, Designs and Trade Marks as they affect Scientists, Engineers and Metallurgists in India.

T. P. DATTA, Calcutta.

Patents, Designs and Trade Marks are specific rights of "Industrial property" based on the principle that originality of thought of a person is the property of its originator. Every Scientist, Engineer or Metallurgist in India is vitally concerned in the protection of one or more of these rights in different forms, during the pursuit of his professional work. The Patent system protects the enterprises based on new inventions and their development with monopoly during the normal life of a Patent for 16 years. Hence it is essentially advisable for Scientists, Engineers and Metallurgists to adopt a policy of protecting their inventions by Patents, instead of working them openly, or in secrecy, or publishing them in a journal. In India, capital is shy in the matter of developing new inventions and there are many practical impediments for the inventor to develop and protect his ideas. Given proper scope and encouragement, the Indian inventor will rise to the occasion, and contribute substantially to the wealth of the nation. It is suggested, therefore, that Government should earmark a very substantial amount, specifically for promoting the practical utilization of Indian inventions. Towards this end an institute for developing, exploiting and rendering such other necessary assistance to inventors should be immediately started under the guidance and direction of a Committee of experts and competent persons. It has been found by experience that Indian inventors through ignorance of Patent Law, have frequently acted indiscreetly and thus endangered the chance of obtaining valid Patents for their inventions. It is evident that skilful drafting of documents and efficient prosecution of Patent applications demand highly specialised knowledge and sound experience, for which the only means is to contact and consult experienced Patent Attorneys for proper guidance and assistance. After the attainment of freedom by India, national energy and creative genius should be harnessed as never before for the uplift and prosperity of the mass of population in the country. Towards this end the promotion of universal Scientific education, the encouragement of inventive genius, and the advance of social service and conscience of the people of India are essential, if the creative forces that result in useful inventions are to be fully realised and spread on all national historic occasions, including the annual session of the Science Congress, where promising architects for future greatness of India periodically gather together and hold momentous discussions of national and Scientific importance.

DISCUSSIONS

I. MOTION OF COMPRESSIBLE FLUIDS.

Section of Mathematics.

Chairman : PROF. V. V. NARLIKAR (Banaras).

1. B. R. SETH (Kharagpur).

In the treatment of problems on compressible flow, a number of assumptions, made to simplify the mathematical treatment of the problem, vitiate the utility of many solutions that have been obtained. Quite often viscosity and heat conduction are neglected. This amounts to the neglect of molecular-transfer of phenomenon. If the gas is taken as non-viscous, surfaces of discontinuity have to be assumed, and then the solution is not unique. Hadamard's three postulates for solving physical problems are :—

(1) The solution should exist ;
(2) It should be unique;
(3) It should be stable.

It is generally not possible to satisfy the postulates of uniqueness and stability in most of the existing solutions in compressible flow. From the mathematical point of view the present state of the compressible flow solutions is therefore anything but satisfactory.

To make some progress we can adopt one of the following methods :—

(*a*) Solutions with continuous velocities may be determined and then examined if they are physically possible;

(*b*) Experimental knowledge may be used to postulate the kind and position of discontinuities that can occur;

If we adopt the first method we have to solve the Navier-Stoke's equations of motions. Neglecting viscosity we find that they cannot be exactly solved even for a sphere or a cylinder moving uniformly through it. J. R. Foote has recently adopted a method, used by B. R. Seth to discuss the motion of a sphere through a non-viscous gas. He introduces an extraneous force in the direction of motion, satisfies the boundary conditions, and then examines the nature of this solution. He does not neglect the second-degree terms, and also does not assume the motion to be irrotational. He finds that for a particular value of the adiabatic constant, the motion is almost irrotational. He also finds that compressibility plays the same part as viscosity does in Seth's solution. It is possible that this method can be used to get some more solutions. The uniqueness and stability of such solutions remain an open question.

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2. G. BANDHYOPADHYAY (Kharagpur).

The study of non-linear plane compressible flow originated in Riemann's study of sound waves of finite amplitude. Basing essentially on the older methods there has been considerable development of the subject in recent years. Shocks and their interactions have received special attention. The non-rigidity of the vessel does not appear to have attracted any attention so far and a preliminary study shows that under certain simplifying assumption which needs closer examination a correspondence can be established for flows in rigid and non-rigid vessels. The change in the nature of the shock velocity in an elastic tube has been studied for a particular case by applying this method.

II. MATHEMATICAL TEACHING AND RESEARCH IN INDIA.

Section of Mathematics.

Chairman: PROF. V. V. NARLIKAR (Banaras).

1. Dr. R. Vaidyanathswami opened the discussion by saying that in the teaching of Mathematics certain ideas such as the theory of structure, ideas of groups and topology etc. should be introduced. These ideas, he said, were not absolutely new, but they were inherent in the very nature of mathematical thought and should be brought forth more prominently.

2. Dr. A. N. Singh said that some of these topics were more or less matters of notations and students should not be unnecessarily overburdened with such notations and symbols. Regarding research in Mathematics he said that more attention should be given to what the Indians are best fitted to do.

3. Dr. R. N. Sen pointed out that since their university days, progress in Mathematics had been enormous; the approach to mathematical ideas had changed considerably and had been progressing towards generalisations. He was therefore of the opinion that syllabuses in Mathematics should be so modelled that the present generation of students coming out of the universities may get the advantage of undertaking fruitful research work.

4. Dr. N. G. Shabde said that a uniform syllabus of Mathematics for all universities of India was desirable and suggested that a committee might be set up to consider the matter.

5. Dr. R. D. Misra, on the other hand, was of the opinion that every university should be left to itself to choose its curriculum. Regarding research papers published in various mathematical journals, he said that much of it was trivial and should not have been published.

6. Prof. S. N. Bose pointed out that the raising of the standard of publication too high would discourage research activities and would ultimately be detrimental to the interest of even important research work.

III. MEDIUM OF INSTRUCTION AT THE UNIVERSITY STAGE.

Section of Mathematics.

Chairman: PROF. V. V. NARLIKAR (Banaras).

1. Dr. Brij Mohan opened the discussion by saying that it was high time that the teaching of Mathematics should be imparted through the medium of the 'Rashtrabhasa', namely Hindi. He said he had been giving his best thoughts over the matter for some time and he demonstrated the results of his thoughts on the blackboard by giving some examples, even to the extent of using the numerals in Hindi.

2. Dr. A. N. Singh agreed with Dr. Brij Mohan in the matter of imparting instruction through Hindi as it would make the teaching more effective but was of the opinion that the numerals and such other notations and terms as were in universal use should be retained. He placed before the meeting a few question papers in support of his contention.

3. Dr. Gorakh Prasad said that it was not necessary to retain any foreign word or symbol and claimed that Hindi was powerful enough to express any mathematical idea involving even symbols and technical terms.

4. Dr. N. G. Shabde while supporting regional language as the medium of instruction said that nothing should be done in undue haste to effect a wholesale change in the medium of instruction.

5. Prof. S. N. Bose in summing up the discussion laid stress on the usefulness and necessity of imparting instruction through the medium of regional language.

IV. STATISTICAL PROBLEMS IN ECONOMETRIC MODELS.

Section of Statistics.

Chairman: DR. K. R. NAIR (Dehra Dun).

1. *Dr. A. R. Sen* (*Lucknow*) opened the discussion by referring to the two models, *viz.*, Non-stochastic and Stochastic, in which Economic problems could be broadly classified. He said that Economic relationships were, in general, stochastic; that is, they involved variables whose properties could be described with the aid of

probability distributions and that non-stochastic models could be treated as a special case of the former when the non-observable random variables affecting the observations were absent. He said that he would confine his remarks to stochastic models only and, in particular, to linear regression models.

He next described the statistical problem in regression models when one or both the variables were subject to error. Discussing the problem of prediction in the case of uncorrelated errors of the dependent variable when it was subject to error and the independent variable was fixed, he said that the solution was well-known, namely, the method of least squares. The method would, however, break down when it was desired to determine "Structural relationships", *e.g.*, the actual decline in demand when the price of a commodity as fixed by Government (say) increased by a known amount. Such problems were more realistic and were also of considerable importance in formulating economic policies. For that a stochastic scheme might be needed where all the variables in the system were subject to error. It was, however, assumed that there were no errors in the equations. Workers prior to Wald held that the linear structural relationship could not be estimated without *a priori* knowledge regarding the standard deviations of the errors in the two variables. In a paper in Economica (1939), R. G. D. Allen had shown that the structure could be estimated if any two of the three quantities, the two standard deviations of the errors in the two variables and the correlation coefficients between the errors, were given *a priori*. Wald (Annals of Mathematical Statistics, 1940) had shown that it was possible to obtain an estimate of the structural coefficients from the observations without *a priori* knowledge of the standard deviations of the errors in the variables for the case where the errors in the variables were uncorrelated. He had, in fact, obtained sufficient conditions for the consistency of the resulting estimate. Essentially, his method consisted in dividing the observations into two groups G_1 and G_2, G_1 containing the first half, (x_1', y_1'), (x_2', y_2') . . . . (x_m', y_m') and G_2 the second half $(x_{m}'_{+1}, y_{m}'_{+1})$, ... (x_N', y_N') of the observations, the subdivision being defined independently of the errors involved in the variables. This subdivision could be done in a large number of ways. The subdivision which provided the most efficient estimate of the structural parameter α was obtained if the observations were first ordered such that

$$x_1' \leqslant x_2' \leqslant x_3' \; . \; . \; . \; . \leqslant x_N'$$

and the point (x_i', y_i') was assigned to one or the other of the groups G_1 or G_2 according to some definite rule. One such rule would be to assign the point (x_i', y_i') to G_1 if the number of elements $x_j'(j \neq i)$ of the series x_1' . . . . . . x_N' for which $x_j' \leqslant x_i'$ was less than $m (= N/2)$. If the number of elements $x_i'(j \neq i)$ for which $x_j' \leqslant x_i'$ was $\geqslant m$, the point (x_i', y_i') would belong to G_2. The most efficient estimate of α in that case was given by

$$\frac{(y_1' + \; . \; . \; . \; . \; y_m') - (y_{m+1}' + \; . \; . \; . \; . \; + y_N')}{(x'_1 + \; . \; . \; . \; . \; x_m') - (x_{m+1}' + \; . \; . \; . \; . \; . \; x_N')}$$

Wald had further shown that even if the structural relationships were known accurately for the linear model, when both the variables were subject to error, the predicted value of y for a new observation x, not belonging to the set of the known observations (x_1', y_1') . . . . . . (x_N', y_N'), was biased.

Bartlett (Biometrics, 1949) had extended Wald's original method to the use of three groups instead of two. Then observations were first arranged in an ascending order of magnitude and next divided into three groups of approximately the same size but non-overlapping. The middle group was rejected and the first and the third groups used as in Wald's procedure.

He then referred to the method of weighted regression developed by Koopman (Linear Regression in Economic Time series, Haarlem, 1937) in the solution of the general problem where there were q identified linear relationships between the p economic variables Mi (time) given by $\alpha_{\nu o} + \sum_{j=1}^{p} \alpha_{\nu j} \, M_{jt} = o (\nu = 1, \; 2, \; . \; . \; . \; . \; . \; q;$ $t = 1, \; 2, \; . \; . \; . \; . \; . \; N)$ and $X_{it} = M_{it} + \eta_{it}$ $(i = 1, \; 2, \; . \; . \; . \; . \; p; \;\; t = 1, \; 2, \; . \; . \; . \; . \; N)$. X_{it} being observable variables, η_{it} the random disturbances and, further, $\alpha_{\nu o}, \alpha_{\nu 1}, \; . \; . \; . \; . \; \alpha_{\nu p}$ were structural coefficients to be estimated.

Dr. Sen then passed on to the other important aspect of the problem, namely, when the errors in the equations were important and the errors in the variables could be assumed to be negligible. He referred in this connexion to the works of Koopman (Econometrica, Vol. 17, 1949), and of Koopman, H. Rubin and Leipnik (Statistical Inference in Dynamic Economic Models). He, however, confined his observations mainly to economic time series where the successive observations were correlated. He said that if the demand for some commodity were regarded as a linear function of income, price of the commodity, etc., the errors in that relationship at successive time periods might be generally correlated and it was desirable to use a method of analysis which took account of that fact. Given the data satisfying such a model as the above, the first problem was a test of significance to test the presence of serial correlation, if any, in the error term. Although the position was fairly satisfactory for large-sample test, it was not so when the sample size was small. He then described in this connexion the various tests of significance, mainly those of R. L. Anderson (Annals of Mathematical Statistics, 1942), Von Neumann (Annals of Mathematical Statistics, 1941), Durbin and Watson (Annals of Mathematical Statistics, 1951) and said that although R. L. Anderson's statistic (for Lag L, $LR_N=\frac{LC_N}{V_N}$ where LC_N was the antocovariance for lag L and V_N the variance) had a known distribution, it was based on a circular definition of the population which was rarely realised in economic time series. On the other hand, Von-Neumann's Statistic (ratio of mean square successive difference to variance) had the objective of detecting deviations from the null hypothesis but its exact distribution was so far unknown. He said that the only satisfactory tests, as far as he was aware, were those given by Watson and Durbin (Annals of Mathematical Statistics, 1951) who had proposed certain non-circular statistics for which the exact distributions could be obtained by applying R. L. Anderson's results.

Dr. Sen concluded his remarks by laying stress on the proper method of analysis once the tests demonstrated the absence or presence of serial correlation in the errors. He said that the use of well-known least square techniques for the estimation of regression coefficients was valid if the tests showed that the errors were not serially correlated. In case, however, the tests indicated the presence of serial correlation, further investigations were necessary for deciding the stochastic process which had generated the errors and large samples might be necessary to decide the process with any reasonable degree of accuracy. All that was directed to obtain knowledge about the form of the distribution of the errors in order to be able to device a suitable method of analysis when the errors were serially correlated. As far as the speaker was aware, the problem was still unsolved, although a proper approach could be made through empirical investigations.

2. *Dr. P. K. Bose* (*Calcutta*) said that Dr. A. R. Sen had discussed the problem of estimating the parameter in the linear regression form when both variables were subject to error. He had discussed the methods of Profs. Wald and Bantlett for estimating the parameters by dividing the set of observations into two or three subdivisions. He pointed out that the problem of estimating the parameter in the linear case had also been investigated in the Indian Statistical Institute by Model Sampling Experiments and that the method of group average had been adopted for estimating the parameter in the linear case.

The results of these investigations had been published by K. R. Nair and M. P. Srivastava, and K. R. Nair and K. S. Banerjee in Sankhya (1942).

3. *Dr. A. K. Gayen* (*Calcutta*) discussed a problem of prediction on the time series of an index of daily maximum price of a certain listed security for a period of about two years and a half, of the Calcutta stock market. The most satisfactory way of fitting a trend was by the method of least squares, but so far as the present problem was concerned it was pointed out that a straight line or any polynomial trend fitted by the method of least squares to the limited segment of the material might later be found to be located too high or too low, when additional data were secured. The polynomial trends did not admit of extrapolation except at grave risk.

The data presented a trend which as such could not be corrected by the standard methods for purposes of extrapolation of the basic series in some immediate future. The study revealed that some order of difference series (in the present problem in third-order) might be trend-free and fore-casting might be made on the series of specially the systematic part of the variable. With the predicted value in the difference-series, it was possible to go back to the original one. It was shown by the speaker that this procedure might lead to satisfactory results.

4. *Mr. T. Ghose* (*Calcutta*) said that the study of time series for prediction purposes needed very careful analysis not only of the series under reference but of other relevant and important factors as well. Statistical processing of share prices for finding out a more regular rhythm helpful for prediction was to be compared along with other factors, such as business activity, production trend of the commodity to which the share related, price trends of other selected shares quoted in the stock exchange, etc. That would give an idea of major and minor

correlated factors. It was also desirable to subdivide the series into different suitable periods. After all, it was necessary to study the series along with other related factors with necessary corrections, if possible, for wind falls. That correction could be made from experience gained from a knowledge of the influence of like events (if any) on the series in the past.

5. *Dr. A. C. Das* (*Calcutta*) considered two different models for demand analysis. The first was

$$d_t = d(p_t) + \xi_t$$
$$s_t = s(p_{t-1}) + \eta_t$$
$$p_t = p_{t-1} + c(d_{t-1} - p_{t-1}) + \zeta_t$$

where ξ_t, η_t and ζ_t were disturbances. Assuring these to form stationary processes, the functions to be linear and the sample size large, Bentzel-Wold and Wald had suggested the method of least squares as a suitable method. In the stationary normal case, the exact distribution could also be found out. Besides, if some were evolutive, the parameters of the stationary part could be validly estimated by the method of least squares.

The second model considered by the speaker was

$$d_t = \beta \phi_t + p_t^{(m)} + \varepsilon_t$$

where $p_t^{(m)}$ was a polynomial in t, ε_t was a random process, β the elasticity of demand, and d_t, p_t were the logarithms of demand and price respectively. In the above, if m were unknown, successive differences of d_t and p_t would be taken, and by finding regression, the degree of the polynomial would be determined. That, concluded the speaker, was the generalization of Pigon's method.

6. *Dr. Rajalakshman* (*Madras*) said that the quantitative data that arose in Social Sciences were influenced by a large number of forces that varied considerably in time. To proceed with statistical analysis and take up problems associated with prediction. It was necessary to locate some important factors that remained stable for the period under consideration and set up a suitable mathematical model for that pattern. For the criticism that forces influencing economic activity had no stable patterns at all, the only justification was that it was impossible to proceed with quantitative analysis unless some forces at least could be assumed to remain reasonably stable during the period under study.

The two main factors that influenced the choice of a model were simplicity and flexibility. While simple specifications were easy to handle for statistical analysis, they were usually rigid and not realistic. Consequently, a compromise was essential usually in selecting a fairly simple model that was at the same time reasonably flexible and presented a good picture of the phenomenon. From the statistical point of view, when once a mathematical model had been chosen, the two main problems were those of testing its goodness of fit and of ascertaining whether there was any other alternative more appropriate than the one selected.

One class of data that often arose in studies of social sciences were time-series. The classical approach of analysis by using the periodogram after eliminating the trend and seasonal variation had been criticised as unrealistic and was also shown to lead sometimes to fallacious conclusions. Since those observations were usually correlated, that fact had been taken into consideration for suggesting the linear autoregressive schemes where a random element entered into the structure of the model itself. That model no doubt was an improvement in being more flexible and realistic than the previous approach, but it was also criticised as being too simple and inadequate to represent complicated economic activity. But, on the other hand, the statistical analysis had presented complicated problems that had yet to be solved fully. The theory developed so far was asymptotic and hence suitable only for large samples while, in practice, observations were rarely available for the length of time required during which it was possible to assume reasonable stability of at least some of the important forces. Even here, although there was a goodness-of-fit test on the correlogram, no technique had been evolved to know whether any other alternative model was more suitable than the one chosen. There was another important problem that arose out of the peculiar property of the estimated correlogram. It had been proved that that estimate obtained from a series of observations constructed artificially for an autoregressive scheme, revealed apparently very little agreement with the expected correlogram. Consequently, in practice, by a simple inspection of the observed correlogram it was rather difficult to suspect whether the autoregressive scheme or any other model was suitable for the data.

The speaker concluded by saying that all that showed the complexity of statistical problems that arose even with that reasonably simple mathematical model. So, while the models to be realistic required flexible specifications involving in some form or other the autocorrelations, the corresponding statistical theory had to be developed for reasonably small samples in order to be of practical utility. That called for theoretical research on a variety of econometric models that were appropriate for different phenomena. There was imperative need for undertaking these investigations inasmuch as a quantitative appraisal of any complicated phenomena was preferable to their descriptive study.

7. *Mr. A. Ghosh* (*Calcutta*) said that the problem of adjusting simple econometric models to changes imposed by governmental activities had been engaging their attention for some time past. He would discuss such a problem based on the input-output models generally popularised by Leontieff.

The speaker considered a simple model consisting of only three sectors, say, agriculture, non-agriculture and households, with the further supposition that there were no transactions in the non-agriculture or the household sectors. It was well-known that the prices in such a model would be determined from the set of equations

$$-\rho_1+a_{21}\rho_2+a_{31}\rho_3=0$$
$$a_{12}\rho_1-\rho_2+a_{32}\rho_3=0$$
$$a_{13}\rho_1+a_{23}\rho_2-\rho_3=0$$

where ρ_1, ρ_2, ρ_3 were the respective prices, on condition that the determinant was zero.

If the Government decided that the price of household sector was to be increased as their investment coefficient defined as

$$\frac{\rho_1 x_1}{\rho_2 x_2+\rho_3 x_3}$$

where x_1, x_2, x_3 were the respective net outputs, was less than 1, that would necessitate a transfer of real assets from the household sector to the other sectors. The price, therefore, of agricultural output would have to be raised to make the investment coefficient greater than 1. At the same time, the government realized that the investment coefficient of non-agriculture or agriculture must not be tampered with. Under such a condition, the model would either have to be scrapped or it must be assumed that the government was in a position to change the parametric values in such a way that the equilibrium of the model as a whole was maintained. The problem in such cases was to make realistic assumptions regarding a class of parameters without tampering with the other parameters or the model. In the case cited by the speaker, for example, the assumption was that the parameters were subject to alteration with the restriction that the ratio $aij/\beta j$ was unaltered, where βj represented the investment coefficient of the Jth group.

The speaker concluded by saying that from the standpoint of a political authority, therefore, the parameters in a model were different from the case of a single unit. The parameters in those cases represented certain structural relations which could not be affected from within, so to say, but which could be affected from the outside, subject to some more basic restrictions.

8. *Mr. K. C. Basak* (*Calcutta*) also participated in the discussion.

Section of Physics.

Chairman—Dr. N. R. Tawde.

1. Combustion and Flames & Explosion Phenomena.

SPECTRAL STUDY OF THE ETHYL ALCOHOL FLAMES

N. R. Tawde, Bombay.

Experiments on the spectral development of the radicals C_2, CH, OH, and CHO in the ethyl alcohol flames have been carried out at various stages of combustion. The measurements involve the overall intensities of the representative bands of C_2 (Swan), CH (4315), OH and CHO group relatively to each other, and the vibrational intensity distribution among the bands of C_2 (Swan) System. Flame temperatures have also been obtained simultaneously by the "sodium line reversal" method.

The fall and gain in intensity of the various spectral radicals shows that CH is formed at the exxpense of C_2 by the reaction—

$$C_2+OH=CH+CO$$

While the excitation of C_2 appears to be thermal, the formation and excitation of CH in the inner cone seems to follow from chemiluminiscent process.

The attainment of maximum temperature in the inner cone has been found to lag behind the stoichiometric mixture. But the reaction giving OH is very active at the stoichiometric mixture, showing that the temperature rise is not in harmony with the energy release. This is attributed to the loss of energy to (*a*) grid and (*b*) C_2 molecule for dissociation, evident in the flame at relatively rich mixtures.

The comparison of vibrational temperatures with the flame temperatures shows that there is lack of equipartition of energy between translational and vibrational degrees of freedom.

PROPAGATION OF FLAME THROUGH DUST CLOUDS

S. Guruswamy, Bihar.

Abstract

Existing information on dust explosions is reviewed. To obtain a working hypothesis on the propagation of flame through dust clouds, the dust flame is studied theoretically on the basis of a study of the gas flame by Mallard and Le Chatelier. In the dust flame, heat is transferred both by convection and radiation, and the diffusion of oxygen governs the rate of burning of the individual particles. These two factors control the thickness of the burning zone in the dust flame which is estimated to be 100 to 1000 times greater than that estimated for flames of premixed gases.

Experimental results on the velocity of flame propagation through dust clouds of dextrin and aluminum are in reasonable agreement with theoretical expectations.

STABILITY AND STRUCTURE OF SLOW BURNING GASEOUS FLAMES

D. Sen, Bihar.

Abstract

The stability of flames of lean mixtures of propane and air, in the Flat Flame Burner, has been studied by photographing the flow pattern in the unburnt gas ahead of the flame front. This burner was designed by Egerton, Powling and Thabet in order to stabilise very slow flames of combustible mixtures near the limits of inflammability : it gives a flat disc-shaped flame, floating well above the burner rim. The gas flow and burning velocities are found to be equal in the centre of the flat flame but not near the burner wall as in ordinary conical flames. The paper discusses how the flame is stabilised under this condition and the mechanisms of its blow off and flash back.

Shadowgraphs and schlieren photographs of the flat flame have been obtained. The burning velocity of the flame has been found to remain unchanged whether measured from any of these two images or from the luminous surface. The thickness of the flame zones of reaction and of pre-heating have been determined from the schlieren photographs, and the approximate temperature distribution across the flame front has been calculated from these measurements. The paper deals with how the flame front is maintained, taking into consideration this temperature distribution.

ABSORPTION OF COSMIC RAYS IN LEAD

P. S. Gill, Aligarh

In recent years a number of workers have observed anomalies in the absorption of cosmic rays in lead in the equatorial regions. The abnormalities in the lead absorption curve, however, occur at different thicknesses of lead as reported by different authors.

In 1950 Dr. W. F. G. Swann and the author planned an experiment to investigate these anomalies in detail at low and high latitudes. Three exactly similar cosmic ray telescopes consisting of four trays of G-M tubes were constructed. Each tray consisted of 17 G-M tubes and presented a sensitive area of 100 square centimeters. The outer two trays were separated by a distance of 80 cms. which allowed fifty five centimeters of lead to be inserted in between. The quadruple coincidences for each thickness of lead were recorded. The data was straddled in such a manner as to minimize the intensity variations caused by meteorological elements.

The data were collected at Swarthmore (52° geomagnetic North, latitude, altitude 296 feet); Aligarh (Geomagnetic latitude of 18° 12′N, altitude 600 feet); and at Gulmarg (Geomagnetic latitude 23°32′ N, altitude 8896 feet). The data at each thickness of lead were accurate to within one per cent.

Lead absorption curves for cosmic rays at all the stations showed no abnormalities at all. It was concluded that the previous anomalies must have been caused due to the different geometries of the telescopes employed or the manner in which lead was placed.

THE 24-HOUR VARIATION IN COSMIC RAY INTENSITY AND ITS PROBABLE ORIGIN IN THE SUN.

V. A. SARABHAI, AHMEDABAD.

Synopsis of the talk by *Dr. V. A. Sarabhai* at the Cosmic Ray Symposium held at the Indian Science Congress at Lucknow.

Results obtained at the sea-level station of Ahmedabad and the high altitude station of Kodaikanal have revealed the existence of a diurnal variation of meson intensity, which is of extra-terrestrial and probably solar origin. Recently the Carnegie Institution of Washington data for the period 1937 to 1946 were harmonically analysed. The analysis reveals that the time series for percentage amplitude M^D and the hour of maximum θ^D at the widely separated stations of Huancayo, Cheltenham and Christchurch undergo large long-term worldwide changes. The parallelism is better illustrated during years of low sunspot activity.

These results confirm the view that the pressure-corrected meson intensity variation is caused by an anisotropy of the primary cosmic rays, connected with the emission of high energy charged particles from the sun. Also, the sun seems to be a continuous source of cosmic radiation, the activity of emission varying broadly in step with the solar cycle.

THE 24-HOUR VARIATION OF COSMIC RAY INTENSITY AND ITS PROBABLE ORIGIN IN THE SUN.

R. P. KANE, Ahmedabad.

Synopsis of the talk by *Dr. R. P. Kane* at the Cosmic Ray Symposium held at the Indian Science Congress at Lucknow.

The meson intensity at sea-level is found to show a daily variation with the hour of maximum at about noon local time. These variations can be partly caused by meteorological effects, corrections for which can be applied from considerations of the various processes involved therein. Geomagnetic effects need not be taken into consideration because they are latitude dependent to a great extent while the meson daily variation is more or less worldwide in nature.

After corrections for meteorological effects are applied, there seems to be still left a residual diurnal variation of meson intensity. Results obtained at Ahmedabad over a period of about two years, indicate an amplitude of about 0·5% with the hour of maximum at about 10 hr. I.S.T. One is led to conclude that this is of extra-terrestrial origin and is probably caused by emission of cosmic ray particles from the sun. A connection between the amplitude and phase of the diurnal variation is suggested.

PRIMARY COSMIC RADIATION AT VERY HIGH ENERGIES

($>10^{12}$ e.v.)

D. LAL, Bombay.

The energy spectrum of primary components of cosmic radiation is obtained by measuring their flux as a function of geomagnetic latitude. This gives the integral spectrum upto ∽ 15 Bev. for protons. At higher energies the measurements are based on their interactions. The measurements on the occurrence of extensive showers and intensity of μ mesons at different depths have been used to obtain the flux of high energy primaries. Recently a more direct method has been employed for the flux determination of the very high energy primaries. Photographic emulsions are alternately packed with brass absorbers and flown at high altitude. Energetic nuclear explosions lead to the production of showers of charged and neutral mesons. The neutral mesons decay into 2 γ rays which start an electron photon cascade in the stack.

The energies of the showers can be estimated either from the angular opening of the shower or from the growth of the soft component as a function of depth in the stack. In this way we find that the flux of protons ($E>1{\cdot}6\times10^{12}$ev.) is $\cdot29\pm\cdot07$/meter^2/sec./steradian. The ratio of protons to α particles in the same velocity region is within the experimental statistics equal to the ratio of about 12, found at lower energies.

It has been shown by Peters (1953) that within experimental errors all measurements of the primary proton intensity from 5×10^8ev. to 10^{16}ev. can be represented by the formulae

$$\log_{10} N_p(E)=6{\cdot}73-0{\cdot}0495\ [11{\cdot}9+\log_{10}\ (1{\cdot}7+E)]^2$$

where $\bar{N}_p(E)$ is the number of proton incident per cm^2/sec./steradian whose energy exceeds E Bev.

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Recent Advances in Thermodynamics.

The following members took part in the discussion.

Dr. B. N. Srivastava, Lucknow; Dr. F. C. Auluck, New Delhi; Dr. R. N. Rai, New Delhi; Dr. V. R. Thiruvenkatachar.

V. STATISTICAL METHODS IN BIOLOGICAL SCIENCES.

(Section of Statistics, Jointly with Sections of Botany and Agricultural Sciences.)

Chairman : DR. N. PARTHASARATHY (New Delhi).

1. DR. C. R. RAO (Calcutta) opened the discussion by giving a general survey of statistical methods in biological sciences and said that in the development of the statistical methods, the statisticians owed much to the biologists. He requested the biologists to tell the statisticians how far the present methods were suitable to them and what other problems remained unsolved.

2. DR. P. K. BOSE (Calcutta).

The different statistical techniques which are mostly used now-a-days for solving different types of problems in biological sciences, were first introduced by Prof. R. A. Fisher while he was working at Rothamsted, England in 1920 and afterwards. The methods were devised in connection with the agricultural experiments. The principles of experimentation which originated in agriculture are finding increasing application in other fields of allied sciences. The difficulties which one encounters in any particular branch will not be similar to those of another but the solutions arrived at in one field are often of material help in another.

The problem of classification and discrimination is very important in experimental procedures. The problem of classification may be stated as follows: *(i)* we have a number of individuals of whom several measurements are available, we want to classify them into different groups with minimum overlapping; *(ii)* on the basis of multiple measurements, suppose we have two populations of individuals π_1 and π_2. The problem is that of classifying an individual into one of the populations π_1 and π_2 on the basis of the measurements. The problem of discrimination may be stated as follows :

Suppose we draw three samples S_2, S_2 and S_3 from three populations π_1, π_2 and π_3 respectively. On the basis of the samples, it is sometimes necessary to know whether the population π_1 is nearer to π_2 or π_3? For the solution of these types of problems, we need a measure of divergence between the different populations.

So far as the problems of classification are concerned, the solution has been given by Fisher and Wald. Measures of divergence have been given by Mahalanobis, Hotelling, Bose and Roy.

Suppose we have two species of N_1 and N_2 observations and for each individual, we have p measurements. We want to know whether the two species are different. For the solution we seek a linear function of the measurements which will maximise the ratio of the difference between the means of the two classes to the standard deviation within classes. The linear function is represented by

$$X = \sum_{i=1}^{p} \lambda_i X_i$$

Let the difference between means of x_i be represented by d_i. Represent the sum of squares or products from the specific means within classes by S_{ij} (i, j = 1, 2,.........p). The difference between the means of X in the two species is

$$D = \sum_{i} \lambda_i d_i$$

while the variance of X within classes is proportional to

$$S_X = \sum_{i}\sum_{j} \lambda_i \lambda_j S_{ij} \quad (i, j = 1, 2, \ldots\ldots\ldots p)$$

The particular function which best discriminates the two species will be one for which the ratio D^2/S_X is greatest by variation of the p-coefficients λ_1, γ_2,.........γp independently. A complete solution of this problem has been given by Fisher.[1]

Suppose we have another individual with p measurements. We intend to know to which species the particular individual belongs. Wald[2] has shown two methods of solving the problem (*i*) when N_1 and N_2 are large and (*ii*) when N_1 and N_2 are large.

For the time being we assume that N_1 and N_2 are sufficiently large. By using Wald's criterion, let us denote by π_1 and π_2 the populations of the first species and the second species respectively. The hypothesis tested in this problem is that the individual is drawn from π_1. We calculate

$$\alpha_1 = \lambda_1 X_{11} + \lambda_2 X_{12} + \ldots\ldots + \lambda_p X_{1p}$$
$$\alpha_2 = \lambda_1 X_{21} + \lambda_2 X_{22} + \ldots\ldots + \lambda_p X_{2p}$$
$$U = \lambda_1 X_1 + \lambda_2 X_2 + \ldots\ldots + \lambda_p X_p$$

where X_i is the value obtained by this individual on the i-th measurements and U is the value obtained by the individual for the linear function α. Then the critical region for rejecting the hypothesis with the least risk of both kinds of error, that in accepting the hypothesis when it is false and rejecting the hypothesis when it is true, is given by[3]

$$U \geqslant \frac{\alpha_1 + \alpha_2}{2}$$

Different measures of divergence have been defined by Mahalanobis and Hotelling. The statistics (studentised D^2-statistics) which we are considering here slightly differs from the one (classical D^2-statistics) which was earlier defined by Mahalanobis. Consider two samples of sizes n and n′ from two multivariate normal populations with the same set of variances and covariances. Let a_{ij} and a'_i (i, j = 1, 2.........p) be the respective variances and covariances of the sample. Let a_i, a'_i (i, = 1, 2,.........p) be the sample means.

Then

$$C_{ij} = \frac{n a_{ij} + n' a'_{ij}}{n + n'}$$

Let C^{ij} be the minor of C_{ij} in the determinant $|C_{ij}|$ divided by the determinant itself. Then the studentised D^2-statistics has been defined by Bose and Roy as

$$pD^2 = \Sigma C^{ij} (a_i - a'_i)\ (a_j - a'_j)$$

The above statistics may be utilised for studying the difference between the two species so far their mean values are concerned. A full discussion of this problem has been given by Bose and Roy[4] and Bose.[5]

The problem of discrimination and classification of different multivariate normal populations (with the same set of variances and covariances but with different sets of means) has been tackled defining studentised D^2-statistic. But the problem yet remains to be attacked when the populations differ in sets of variances and covariances and when it is sought to discriminate between and classify them in the light of these sets. The first step towards the solution of this type of problem is to define a statistic which will test whether the two samples drawn from two multivariate normal populations can have the same set of variances and covariances or to have distinct sets? Solution of this problem has been given by Roy. Starting from a linear compound of variates and so choosing the compounding coefficients as to make a maximum the ratio of the variance of the first sample and the variance of the second sample for the same character one finds that the maximised value of ratio leads one in the case of p-variate populations to as many as p-studentised statistics. Of these it is found that one is a true maximum and another is a true minimum and the rest are stationary values. Roy[6] has found out the sampling distributions of these statistics.

Another problem of discrimination may be stated as follows. Suppose we draw l samples $S(1)$, $S(2)$,…………$S(l)$ of sizes n_1, n_2,…………n ·, mean values $x(1,i)$, $x(2,i)$……$x(l,i)$ and variances and covariances $a(1,ij)$, $a(2,ij)$…………$a(l,ij)$ from l, p-variate normal populations with mean values $\xi(1, i)$, $\xi(2, i)$……… $\xi(l, i)$ $(i=1, 2,\ldots\ldots\ldots p)$ and a common set of variances and covariances $\alpha''(i, j)$. We want to test the hypothesis $\xi(1, i)=\xi(2, i)=\ldots\ldots\ldots\ldots=\xi(l, i)$ $(i=1, 2,\ldots\ldots\ldots p)$. For this type of problem of classification Roy and Hsu have constructed another set of p-statistics denoted by t_1^2, t_2^2………t^2_p. A full discussion of this has been given by Roy.[7]

In this brief discussion, I have tried to give in broad outline the different statistical procedures which are used in the problems of classification and discrimination. For biologists these statistical methods will prove very useful.

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4. R. C. Bose and S. N. Roy, Sankhya, Vol. 4, pp. 19-31.
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3. DR. K. KISHEN (Lucknow).

In the short time at my disposal, I propose to deal briefly with the topic, in itself vast, of statistical methods in agricultural field experimentation. One of the important problems which an agricultural research worker is often confronted with is the evolution of high-yielding varieties of agricultural crops, finding out the best manures or fertilizers singly or in combination which give the highest yield, investigating the best agricultural practices, etc. Before the advent of modern statistical methods in field experimentation, the experimenter often used to divide his field into as many plots as there were treatments to be tested and draw his conclusions regarding the superiority of one treatment over another on the basis of such an experiment conducted over one or more years. An excellent example of such an experiment is provided by the classical manurial experiment on wheat in the Broadbalk field at Rothamsted which was started by John Bennet Lawes in 1843 and is still in progress. In this field, about 20 long strips of land, each of half an acre, were taken and different manurial treatments were applied, one to each strip (or plot). The total yields of wheat in each of these plots were recorded at harvest in 1844 and subsequent years, with more or less the same treatments repeated year after year.

It is unnecessary to dilate on the obvious defects of such a manurial experiment. Unless the differences in yield between two treatments in such an experiment are so highly pronounced as to be unmistakable, it is difficult to say whether these are ascribable to fertility differences or the effect of the fertilizers. Repetition of the same experiment over a large number of years is also neither a satisfactory nor even a practicable solution of the difficulty. When, therefore, in 1920 R. A. Fisher was appointed statistician at Rothamsted to analyse the collected data for experiments conducted at Broadbalk and other similar experiments, he was not content merely to analyse the data for these old trials but devoted himself to the development of a powerful statistical field technique which should enable agricultural workers to lay out appropriate and efficient experiments suited to their purpose.

Within a few years, Fisher introduced the basic principles of *replication*, *randomization*, and *local control* which revolutionized the whole technique of field experimentation. As we are all aware, replication of a treatment enables us to compare the variation between treatment means with the variation between plots under the same treatment, or what is called experimental error, and thus enables us to assess whether or not there are any real treatment differences. Randomization, or allocation of treatments to plots at random, ensures that there would be no bias on the part of the experimenter in assigning treatments to plots in the fields, thus leading to a valid estimate of error. Local control, or division of the field into as many blocks as there are replications, results in a diminution of error.

This brings us to the well-known Randomized Block and Latin Square designs, based on these principles, which agricultural research workers all the world over use extensively in their work.

An important problem with which the agricultural worker, particularly the plant breeder, is often confronted with is the selection of the best varieties of a crop from among a large number of available varieties. Owing to the large number of the varieties, if an ordinary randomized block design is laid out, the size of the block would become large and would, therefore, require reduction in order that the elimination of fertility differences might be done efficiently. As a result of recent researches in the design of field experiments, a large number of designs are now available which bring about the desired reduction in the size of the block in such trials. These are known as incomplete block designs because, unlike the ordinary randomized block designs, the number of plots per block in these designs is less than the number of varieties.

Let v denote the number of varieties, k the number of plots per block, b the number of blocks, r the number of times a variety is replicated within a block, and λ_{ij} the number of blocks in which the ith and jth varieties occur together. Such a general design is known to be analysable if it is a connected design.

The concept of connectedness may now be briefly explained. A block and a variety are said to be associated if the variety is contained in the block. Two varieties are said to be connected if it is possible to pass from one variety to the other by means of a chain consisting alternately of varieties and blocks such that any two consecutive members of the chain are associated. A design is then defined to be a connected design if any pair of varieties in it are connected. The following simple lattice design for 9 varieties in two equal groups of sets provides an example of an incomplete block design which is connected :

Block I ...	... 1, 2, 3	Block IV ...	... 1, 4, 7
Block II ...	... 4, 5, 6	Block V ...	... 2, 5, 8
Block III ...	... 7, 8, 9	Block VI ...	... 3, 6, 9

It is easily seen that in this case one can pass from one variety to any other, say 1 to 9, by a chain of varieties and blocks like 1, I, 3, VI, 9 so that the design is connected. It is interesting to note that a simple lattice in one group of sets (consisting of Blocks I, II & III, say, in the above example) does not give a connected design.

If $v_1, v_2 \ldots\ldots\ldots, v_v$ denote the true varietal effects, then $\sum_{i=1}^{v} l_i v_i$, where again $\sum_{i=1}^{v} l_i = 0$, is termed a varietal contrast. It is known from the theory of linear estimation that in a connected design every varietal contrast is estimable. Thus a connected design is analysable. The partially balanced incomplete block designs introduced by Bose and Nair, and later generalized by Nair and Rao, and the intra and intergroup balanced incomplete block designs introduced by Nair and Rao are the two fundamental types of connected designs which include as special cases all the well-known connected designs for large variety trials, *e.g.*, simple, triple, rectangular, and cubic lattices, balanced incomplete block designs, etc. As a result of these investigations, it is now possible to provide the agricultural research worker with an appropriate design which he may require for laying out an experiment on a large number of varieties available with him.

Reference may now be made to experiments which involve a number of interacting factors. In such experiments, the importance of varying one factor at a time, keeping the rest of the factors constant, used to be widely accepted as a sound method of experimentation. It was Fisher who first pointed out the mistakenness of this view and stressed the need for varying all the relevant factors simultaneously, thus introducing the concept of *factorial experimentation*. However, when there are a large number of factors, each at a small number of levels, as in the case of the 2^m factorial designs, or when the number of factors is small but each of the factors involves three or higher levels, the total number of treatment combinations becomes unduly large, necessitating reduction in block size. To bring this about, Fisher introduced the important concept of "confounding". As a result of the investigations of Bose and Kishen into the problem of confounding in the general symmetrical factorial design s^m, where s is a prime positive integer or a power of a prime and m any positive integer, it is now possible to provide the agricultural experimenter with an appropriate design in s^k sub-blocks of s^{m-k} plots each, where k is a positive integer less than m, suited to his purpose. Besides, the researches of Nair and Rao into the problem of confounding in asymmetrical factorial designs, where the different factors involve unequal levels, have placed at the disposal of the agricultural experimenter a large class of designs which will be of use to him in experimenting with two or more factors at unequal number of levels.

In factorial designs involving a large number of treatment combinations, *e.g.*, a 2^8 factorial design (involving 256 treatment combinations), even the carrying out of a single replication is beyond the resources of an ordinary agricultural farm. There is obvious need, therefore, for conducting such a trial only in fractional replication, *e.g.*, a 2^m factorial design in $1/2^k$ replication, having only 2^{m-k} treatment combinations. Fractionally replicated designs were first introduced by Finney in 1945 and were subsequently generalized by Kishen. It must, however, be remembered that since the number of treatment combinations in such experiments is only a fraction of the total number of treatment combinations, considerable skill is required in the planning of such trials in order that no important effects are lost or become indistinguishable from one another. On this account, the device is only of limited utility. However, fractionally replicated arrangements are being used with advantage by agricultural experimenters for conducting, *inter alia,* exploratory factorial experiments involving two levels for each factor.

4. Sri S. S. Iyer (Shahjahanpur).

One of the main functions of the Sugarcane Research Station, Shahjahanpur, is the evolution of high-yielding and high-sugared varieties suitable for the different soil-climatic tracts of this premier cane-growing State of Uttar Pradesh. Varietal selection work is a long process, being spread over 7 or 8 years from the time hybrid fluff or seedlings are received from Coimbatore until a variety is ultimately released to the general cultivator as suitable for a particular tract.

I shall illustrate the important part played by modern statistical techniques at each stage of this long process.

Seedling stage (*1st year*): Every year about 10,000 seedlings get established in the field. Only about 150 to 200 have to be selected out of this large number for the second year seedling stage. Based on growth habit, number of tillers, height, juice quality by refractometer brix, etc., this selection has to be made. Here is a multivariate problem and the method of the discriminant function would possibly be of great utility in reducing the number of varieties to a reasonable and manageable limit.

At this stage of selection work, we have two or three small rows of each variety. With such small row plots, the ordinary statistical designs would be of no use. Special methods developed for such single or double row plots have to be employed in these trials for selecting the best varieties, say, about 70 or 80. This selection is best done by applying the method of the discriminant function.

In the third year we carry out what we call Preliminary Varietal trials. The plots used have still to be necessarily small, say, 18 ft. × 18 ft., and we cannot have more than 2 to 4 replications. These experiments are now laid out in what are called lattice designs, *e.g.*, simple lattice, triple lattice, etc. In this connection, I may mention that hitherto we had to keep the total number of varieties a perfect square, say, 49, 64, etc. But the recent development of rectangular lattice designs has facilitated the testing of numbers of varieties other than perfect squares in valid statistical designs. About 6 or 7 varieties found to show good performance in the Preliminary Varietal trial are taken over to the Standard Varietal trial for comparison with existing standards next year. At this stage our trials generally include about 12 to 16 varieties. These are laid out in regular randomised block designs with 4 to 6 replications and gross plot sizes range from 1/30th to 1/25th of an acre.

Taking into consideration a bulky crop like sugarcane, the experimental plot has necessarily to be fairly big, the gross plot size usually adopted by us being about 1/25th of an acre, as already stated. Consequently, a block containing about 12 to 16 varieties becomes unduly large and it is preferable to use certain incomplete block designs even at this stage. From experience I have found that balanced incomplete block designs with 3 or 4 varieties per block are very efficient in these varietal trials.

Beginning from germination, observations, tiller production, tiller mortality, etc., to the ultimate number of millable canes and cane yield—not to mention the available sugar produced per acre there is an unlimited field and need of application of statistical techniques. But I shall take up only one aspect as an illustration.

In the case of sugarcane, one special problem that arises is the need for periodic sampling of cane for determining its juice quality. The variations in the period of maturity are most important from the point of view of the factory owner. If immature canes of low sucrose and purity are crushed earlier in the season, the recovery is bound to be poor. For these studies, the nature of the sampling units and their optimum distribution have to be studied. It is only the evolution of a suitable sampling technique that would help us in this. Obviously, if the sample is too big, there will be no cane left for ultimate yield estimation and we shall be getting unrepresentative samples. Moreover, the gaps produced by repeated sampling may affect the nature of the population itself. I have carried out some special sampling studies in this direction and my conclusion is that for normal experimental plots of about 1/40th of an acre (net), two random one-foot lengths of cane from each plot would be a suitable sample. To test the adequacy of this technique, two samples from each plot have been independently analysed for different experiments and the relative magnitudes of the sampling error and plot error have also been studied.

Again, we have to estimate damage due to insect pests, diseases, etc. There is no space here to elaborate on the different techniques adopted for various purposes, but it is obvious that without adequate mastery of statistical sampling technique, suitable samples for different purposes cannot be arrived at.

Based on yield, juice quality, resistance to diseases and pests, etc., a few varieties will then be finally selected after a minimum of three years' tests on the research station. But, then, these varieties have also to be tested in different centres of the tract in which they are to be released. For this purpose, we have a chain of zonal centres at each of which zonal varietal trials are carried out for comparing the new varieties with existing standards.

Pooled statistical analysis of the experimental data on varietal trials conducted over representative localities in different seasons will alone finally bring out which varieties are best for a particular tract.

Thus, at the end of these trials, two or three promising varieties that emerge will be multiplied and mill tested; and if found satisfactory, will ultimately be released to the cultivators.

It will be seen from the above that it is only by sound cooperation between the Statistician and the Agronomist at every stage that successful agricultural research can be carried out.

5. Sri K. C. Basak (Calcutta) also participated in the discussion.

VI. STOCHASTIC PROCESSES.

Section of Statistics, Jointly with Sections of Mathematics and Physics.

Chairman: Prof. V. V. Narlikar (Banaras).

1. Dr. D. V. Rajalakshman, Madras.

The need for concepts associated with change of statistical distributions in time and space has given rise to a systematic study of what is known as stochastic processes. The classical theory of statistics can be taken as static without any provision for a dynamic situation introducing change in its set up. Observations are assumed to have been recorded at the same instant of time and are usually taken as independent with the associated theory based on the concept of a random variable or a column vector of them for the multivariate case. The specifications on which this theory has been built is inadequate for the class of problems wherein it is necessary to consider change with correlational dependence. To cover these aspects and develop what can be taken as a dynamic theory, we have to consider a random quantity that depends on an additional parameter which usually happens to be time, introducing the notation of a random function $x(t)$. The theoretical picture presented by this model represents some physical phenomenon that has a random or a stochastic element involved in its structure and is, therefore, called a *Stochastic process*. Just as probability is used both for mathematical and physical concepts, the mathematical model represented by $x(t)$ is also referred to as a stochastic process. The use of the random function x (t) itself leads to a broad classification of these processes into four types, depending on x and t being discrete or continuous. It is also possible to consider processes with more than one quantity x and these are known as simultaneous or multivariate processes, while those involving more than one parameter t are referred to as multidimensional.

Although isolated applications of stochastic processes have arisen since the beginnings of probability theory, a systematic development of their general theory received a great impetus in recent years from situations that often arise in physical sciences, leading to a study of stochastic dependence, as in the theories of Brownian motion, of electrical fluctuations or noise and the statistics of colloidal suspension. Nevertheless, the applications of this theory are not only confined to physics but have been found useful for the study of some problems arising in various other branches like biology, meteorology and social sciences. The mathematical equipment ordinarily needed for these studies can broadly be taken to centre round the theory of random functions involving stochastic continuity and integration, and solutions of stochastic difference and differential equations. Applications in the realm of physical sciences usually require the representation of a physical situation in the form of a differential or a difference equation so that the main problems are those of obtaining their exact or approximate solutions. These problems of physics that cover the aspect of specification are less difficult to solve than the problems of inference like those of estimation and prediction that have to be considered in applications involving the study of stochastic dependence, making use of an observational series or a continuous tract of a specified length.

For various applications of stochastic processes, it is necessary to note the broad division between evolutive and stationary processes. In the former, time plays an active role, introducing dissimilarity in different sections of the series so that the distributional functions are influenced by the initial start point as for example in growth of population, sequential sampling and diffusion problems in physics. For stationary processes, time is a passive medium, retaining the character of the scheme at different sections the same, so much so that the distributional functions are unaltered by translation in time, as for the oscillatory time-series in meteorology and social sciences. A stochastic process x (t) is defined to be completely stationary if the simultaneous distribution at time t_1, t_2,.........t depends on the (n-1) differences. When moments of all order exist, this implies $E[x_1^{a_1} x_2^{a_2} \ldots , . x_n^{a_n}] = \Phi(t_2 - t_1, \ldots\ldots\ldots\ldots, t_n - t_1)$. A process is defined as stationary to the rth order if the above relationship is satisfied for $a_1 + a_2 + \ldots\ldots\ldots\ldots + a_n \leqslant r$. In particular, for the simultaneous process represented by the column vector of random functions $\underset{\sim}{X}$ (t), stationary up to the second order, we have $E[\underset{\sim}{X}(t)] = \underset{\sim}{m}$, a vector of constants that can be assumed as zeros, for convenience, so that $E[\underset{\sim}{X}(t). \underset{\sim}{X}'(t+r)] = \underset{\sim}{V}(r)$, the auto-covariance matrix for any positive $\underset{\sim}{1}$, where $\underset{\sim}{X}'$ is the the transpose of the complex conjugate of $\underset{\sim}{X}$ in general.

Following the pioneering work of Yule on Wolfer's sunspot numbers, it has been observed that linear auto-regressive schemes are appropriate for the study of oscillatory time-series arising, for example, in meteorology and economics. These schemes are a particular form of stationary stochastic processes wherein the correlational dependence of observations is taken into consideration for specifying a suitable model. The problems of inference are studied, taking the given series of observations, after eliminating trend and seasonal variation, as a realisation of the process. The general form of these processes is given by $\underset{\sim}{H}(t) \underset{\sim}{X}(t) = \underset{\sim}{V}(t)$,.........(1), where $\underset{\sim}{H}(t)$ is a matrix operator and $\underset{\sim}{V}(t)$ a vector of random disturbances. In the simplest case of auto-regressive model that can be called the Markoff process, the scheme takes the form $(I + \underset{\sim}{\Lambda} E^{-1}) \underset{\sim}{X}(t) = \underset{\sim}{V}(t)$ in the discrete case and $d\underset{\sim}{X}(t) + \underset{\sim}{\Omega} \underset{\sim}{X}(t)\, dt = d\underset{\sim}{U}(t)$ in the continuous case, where $\underset{\sim}{\Lambda}$ and $\underset{\sim}{\Omega}$ are matrices of constants that satisfy some conditions and E the usual displacement operator. Assuming stationarity at least up to the second order, for sets of n observations, the estimate of auto-covariance matrix in the discrete case can be had from the equation

$$\underset{\sim}{C}\, X(t) = \frac{1}{n-t} \sum_{s=1}^{n-t} [\underset{\sim}{X}(S)\ \underset{\sim}{X}'(s+t)] \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

To test whether these linear schemes give a good fit for any series of observations, asymptotic tests have been proposed on the estimated lag-covariances, using χ^2 approximations. The procedure consists mainly of forming squares of some linear combinations of lag-covariances which follow approximately a multivariate normal distribution. Let us represent the stochastic model given in (1) as $H_{ij}(t)\,X_j(t)=U_i(t)$ with the summation convention for repeated suffixes, and consider the properties of

$$D_{ij}(\tau)=H_{ik}(\tau)C_{jk}(\tau)$$

It can be shown that

$$E[D_{ij}(\tau)]=o \text{ for } \tau>o\,;$$

$$\text{and}\quad E[D_{ij}(\tau)D_{rq}(t)]=\frac{1}{n-t}W_{ir}V_{qj}(t-\tau), \quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(3)}$$

$$\text{where}\quad E[U_i(t)U_j(\tau)]=W_{ij}\,\delta(t-\tau),$$

$$\text{and}\quad V_{qj}(t-\tau)=E[X_q(U+\tau)X_j(U+t)],$$

$$\text{where}\quad \delta(t-\tau)=o \text{ or } 1 \text{ according as } t\neq\tau \text{ or } t=\tau.$$

$$\text{Since}\quad H_{gq}(\tau)H_{hj}(\tau)V_{qj}(t-\tau)=W_{gh}.\,\delta(t-\tau), \quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(4)}$$

corresponding to the operator H, we can define a new operator G such that

$$G_{gq}(t)G_{hj}(\tau)V_{qj}(t-\tau)=\tau_{gh}.\delta(t-\tau) \quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(5)}$$

Using this result with equation (3), we get

$$E[G_{gq}(t)D_{rq}(t)G_{hj}(\tau)D_{ij}(\tau)]=\frac{1}{n-t}W_{ir}\tau_{gh}\delta(t-\tau) \quad\ldots\ldots\ldots\ldots\ldots\ldots \text{(6)}$$

where, if the new operator $G_{ij}(t)$ is of backward length p, then (6) will be valid for $p<\tau\leqslant t$. It can be shown that such an operator exists and in fact it will turn out to be an operator such that $G_{ij}(-t)$ is the appropriate operator for the process reversed in time. When $t=\tau$, this result leads to χ^2 approximations that can be used as a test for goodness of fit. This result provides an approximate method of testing the goodness of fit, although the computational work involved in its application is rather heavy.

Since this is a joint symposium with Mathematics and Physics, my attempt has been to present an introductory account giving the scope of stochastic processes with the solution for the specific problem of testing goodness of fit of a simultaneous autoregressive model in discrete time.

2. SRI P. P. CHATTERJI (Kharagpur).

The general theory of system of equations encountered in the theory of electrical networks having random e.m.f.'s developed by Uhlenbeck and Wang turns out to be applicable, as shown by Spiegel to the various mechanical systems—in particular, to the system of a vibrating string with fixed end points. In order that the theory may be applied to the vibrating string, it is necessary to discretise the string. The following assumptions are made :—

(1) The string is made up of n+2 particles (2 fixed, n vibrating) of equal mass m harmonically bound together by means of massless springs;

(2) The system of particles is acted on by random forces, as a result of which the system vibrates, the vibration taking place in a plane; and

(3) The vibration takes place in a viscous medium, so that each of the particles undergoes a damped vibration. When the results for the discretised system have been obtained, the results for the case of continuous string can be derived by a limiting procedure.

A general stochastic process cannot be described solely in terms of the initial distribution and the transition probabilities. Here, however, the collection $[y_1(t), y_2(t),\ldots\ldots\ldots\ldots y_n(t);\ y'_1(t),\ y'_2(t)\ldots\ldots\ldots\ldots y'_n(t)]$ forms a 2n-dimensional Markoff process governed by the Fokker-Planck or generalised diffusion equation, where the probability density is associated with the distribution of the quantities $[x_1, x_2,\ldots\ldots\ldots\ldots x_2]$ and $[x_1, x_2,\ldots\ldots\ldots\ldots x_{2n}]$ are the 2n variables describing the collection $[y_1(t),\ldots\ldots\ldots\ldots y_n(t);\ y'_1(t),\ldots\ldots\ldots\ldots y'_n(t)]$. By a Markoff process is meant, very roughly, that the future depends statistically on the present state, but not on the past history which led to it.

The probability density function for the system of n vibrating particles can be written, using a well-known result from the theory of multivariate Gaussian distributions. The following results can then be easily derived :—

(1) The characteristic function of the sum of the squares of the deviations of the displacements of the particles from their given initial positions and also the corresponding characteristic function for the continuous string ;

(2)) The mean square deviations of the displacements of the n particles from some given initial distribution and the corresponding mean square deviation for the string; and

(3) The mean square deviation of a single particle of the system, given that initially it had a displacement , and the corresponding limiting case.

3. Sri A. K. Chaudhri (Kharagpur).

The ket for an assembly of electrons is a sum or integral of kets of the form

$$1\,x> = 10>1S> \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

where 10> refers to the orbital and 1S> to the spin variables. Permutation operators P° applicable to the orbital variables and hence operating only on 10> and P° applicable to the spin variables and hence operating only on 1S> are introduced. It can easily be proved that for an interchange of two electrons

$$P^{\circ}_{rs} = -\tfrac{1}{2}\{1+(\vec{\sigma}_r \cdot \vec{\sigma}_s)\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

If we consider the couloumb force between the electrons, it can be shown that the interaction energy V can be written in the form

$$V \simeq V_1 + \sum_{r<s} V_{rs} P^{\circ}_{rs} = V_1 - \tfrac{1}{2} \sum_{r<s} V_{rs}\{1+(\vec{\sigma}_r \cdot \vec{\sigma}_s)\} \quad \ldots\ldots\ldots\ldots\ldots\ldots(3)$$

Equation (3) reveals the curious fact that there is a coupling energy between the spins of the various electrons of magnitude

$$-\tfrac{1}{2} V_{rs}(\vec{\sigma}_r, \vec{\sigma}_s) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

Also, it can be proved that if two of the orbital states of the unperturbed system be the same, then

$$(\vec{\sigma}_1 + \vec{\sigma}_2)^2 = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

Hence, the spins $\vec{\sigma}_1$ and $\vec{\sigma}_2$ are antiparallel. Then two electrons in the same orbital state have their spins antiparallel. Hence it is impossible for more than two electrons to be in the same orbital state.

4. Dr. A. C. Das (Calcutta).

Although methods have been given for the detection and analysis of different types of stationary processes, suitable methods are not yet available for analysing evolutive processes which are frequent in time-series data. Here, under the additive model, *i.e.*, taking an observation as the sum of trend, seasonal and cyclical components, some methods have been suggested for the detection of trend and cyclical components, which, however, suffer from certain limitations. Firstly, the variate-difference method for detecting the degree of polynomial trend is valid only when, in the series, the seasonal and cyclical components are absent; secondly, the periodogram analysis or parallel methods for detecting hidden periodicities are valid only when there is no trend in the series; and thirdly, the method of calculating seasonals by taking a moving average of length equal to its period is valid only when the trend is a polynomial of degree less than three. There is obvious need, therefore, for the introduction of more general methods. I have been able to modify the variate-difference method only in the case when the cyclical component is absent, but no method of detection has yet been suggested when both the trend and the cyclical component are present.

Another aspect is the generalization of one-day time-series to a multi-way time-series, in which much research has not yet been done. Here some points that are of interest in sample surveys may be mentioned. In a stationary process

$$\sum_{i=1}^{h_1} \sum_{j=1}^{h_2} a_{ij}\, x(p+i,\ q+j) = \eta(p,\ q)$$

where either η are independent stationary giving the autoregressive type or x'_3 are independent stationary giving the moving-average type, the space correlation

$$\rho(u,\ v) = \rho(u,\ 0)\ \rho\ (0,\ v)$$

if and only if $a_{ij} = a_{i0}\ a_{0j}$

and in that case consistency conditions are satisfied. In this manner, we can make a multidimensional generalization.

5. Dr. A. R. Sen (Lucknow) said that one of the important problems confronting the experimenter and the statistician in the field was to determine the stochastic process model that would best fit the observations. He thought that the difficulty was more felt in growth problems. The problem was similar to that of non-normality in analysis of variance. Describing another type of problem which was similar to variance stabilization in analysis of variance, he referred to the paper on 'Prediction Problem in time series' presented by Dr. Gayen in the symposium on Statistical problems in Econometric models. He pointed out in this connexion that forecasting actually made on the difference series of the third order which was found to be trend-free and then going back to the original series might not be justifiable.

Citing the references in the field, he said that the systematic theory of stochastic processes was, in the first place, due to Kolmogoroff (Math. Annalen, 1931) and Feller (Math. Annalen, 1936). Lundberg (On Random Processes and their application to sickness and Accident Statistics, Uppsala) had generalized the theory of the discontinuous processes. For a general study, reference might be made to the works of Niels Arley ("Stochastic Processes and Cosmic Radiation"), M. S. Bartlett (Notes of a course given at the University of North Carolina in the fall quarter, 1946) and Feller ("On the theory of Stochastic Processes with particular reference to Applications"—Berkeley Symposium (1945-46). He also referred to the Symposium on Stochastic Processes (J.R.S.S., 1949) in which J. E. Moyal, Bartlett and D. G. Kendall were the principal speakers. For growth problems, he referred to the papers of P. Armitage and D. G. Kendall (J.R.S.S., 1952). He then mentioned some of the important points in the work of Dr. Kallianpur on "Some Topics in the theory of Stochastic Processes" (Thesis submitted at the University of North Carolina).

On the application of Stochastic processes in the field of sampling, Dr. Sen referred to the works of the Scandinavian School, in particular to that of Bentil Matérn in the Line and Sample plot surveys.

Winding up the discussion, the chairman, Prof. Narlikar, observed that Physical problems had now to be reformulated in a different way by means of random functions. There was need for a new formulation of geometry where random functions were utilized. For the mathematician, the associated aspects of calculus of probability would be interesting.

VII. COSMIC RAYS.

Section of Physics.

Chairman : Dr. N. R. Tawde, Bombay.

1. Dr. P. S. Gill, Aligarh, opened the discussion.

He spoke about Absorption of Cosmic Rays in leaf.

2. Dr. R. P. Kane, Ahmedabad.

The meson intensity at sea-level is found to show a daily variation with the hour of maximum at about noon local time. These variations can be partly caused by meteorological effects, corrections for which can be applied from considerations of the various processes involved therein. Geomagnetic effects need not be considered because they are latitude dependent to a great extent, while the meson daily variation is more or less worldwide in nature.

After corrections for meteorological effects have been applied, there seems to be still left a residual diurnal variation of meson intensity. Results obtained at Ahmedabad over a period of about two years, indicate an amplitude of about 0·5% with the hour of maximum of about 10 hr. I.S.T. One is led to conclude that this is of extra-terrestrial origin and is probably caused by emission of cosmic ray particles from the sun.

3. Dr. V. A. Sarabhai, Ahmedabad.

Results obtained at the sea-level station of Ahmedabad and the high altitude station of Kodaikanal have revealed the existence of a diurnal variation of meson intensity, which is of extra-terrestrial and probably solar origin. Recently the Carnegie Institution of Washington data for the period 1937 to 1946 were harmonically analysed and it reveals that the time-series for percentage amplitude M_D and the hour of maximum θ_D at the widely separated stations of Huancayo, Cheltenham and Christchurch undergo large, long-term worldwide changes. The parallelism is better illustrated during years of low sunspot activity.

These results confirm the view that the pressure-corrected meson intensity variation is caused by an anisotropy of the primary cosmic rays, connected with the emission of high energy charged particles from the sun. Also, the sun seems to be a continuous source of cosmic radiation, the activity of emission varying broadly in step with the solar cycle.

4. Dr. Martin A. Pomerantz, U.S.A.

Cosmic Radiation and Solar Activity.

In an attempt to detect correlations between the primary cosmic ray intensity and solar phenomena, a series of balloon flights have been conducted during periods when active regions were observed on the sun. The instruments comprised quadruple-coincidence counter trains containing interposed lead absorber. The data were transmitted by radio to the ground receiving station. Flights were released in accordance with warnings relayed by either the Central Radio Propagation Laboratory at the National Bureau of Standards (Washington, D.C.) or the Cornell Radio Astronomy Observatory (Ithaca, N.Y.) in a cooperative program. The results have indicated that in addition to a general enhancement of the primary flux which may persist for protracted periods (see--M. A. Pomerantz, Phys. Rev. 81, 731 (1951) ; J. A. Simpson, Phys. Rev. 85, 1175 (1951) ; see also Simpson, Fonger, and Wilcox, Phys. Rev. 85, 366 (1952)), bursts of intensity sometimes appear to be correlated with the characteristics of the 200 megacycle radiation emitted by the sun.

Such an effect has been observed in data obtained during several central meridian passages of a particularly active region which persisted for more than a year. The cosmic ray intensity at very high altitudes was monitored when the region was making its first passage across the solar disc on January 27, 1951 ; when it was at the maximum of its activity, during the 5th transit on May 17, 1951, at which time 61 flares occurred in addition to the largest sunspot group ever observed ; and during the 14th and final passage on January 17, 1952. Increases in the cosmic ray intensity were observed to be correlated specifically both with the solar rf radiation and with solar flares.

5. Dr. R. C. Majumder, Delhi.

He spoke on the theory of large cosmic ray bursts.

6. Sri D. Lal, Bombay.

Energy Spectrum of the Cosmic Radiation.

Primary Cosmic Radiation consists of protons, α-particles and to a smaller extent heavier nuclei.

The magnetic field of the earth prevents charged particles of energy lower than a certain limit from reaching the earth's atmosphere and thus cuts off the low energy end of the primary spectrum. Flux determinations for different components of the Cosmic radiation are available at several latitudes for balloon and rocket accessible altitudes. Our knowledge for the spectrum in the energy region above the geomagnetic cut off energies is less complete both for the proton and heavy components. For heavy nuclei ($Z \geqslant 10$) the energy spectrum upto 100 Bev has been obtained by determinations of opening angle of shower particles and by scattering measurements on their collision products. From observations on extensive showers and underground mesons Barett et. al. have determined the flux of particles with energies greater than 4×10^{13} and 2×10^{15} ev. Kaplon et. al. have used photographic emulsions alternated with brass absorbers to pick up events due to particles with energies greater than $4{\cdot}5 \times 10^{12}$ ev.

These are the only measurements available on the high energy side of the spectrum. In order to verify their results and improve the rather meagre statistics we have used an identical brass stack (flown for 6 hours above 90,000 ft. with emulsion surfaces horizontal). A plate deep down in the stack was examined for groups of minimum ionising particles. The energy estimation of the incident primary was done in two ways (*a*) from the half opening angle of the shower particles and (*b*) from the growth of the soft component. There is a good agreement between the energies derived by these two methods.

With the assumption that the flux incident at the top of the atmosphere is isotropic, we find that the integral primary flux of protons ($E > 1{\cdot}5 \times 10^{12}$ e.v.) is ·35. This point along with all other experimental points available upto 2×10^{6} e.v. falls on a curve which joins smoothly to the spectrum at low energies. In agreement with the results of Kaplon et. al. the flux of α-particles is 10% of protons. Occasional observations on heavy nuclei of very high energies make it certain that no drastic change in the exponent occurs. The chemical composition of the primary beam is thus constant not only in the latitude sensitive region but even upto the highest energies observed. Within experimental errors all measurements on the cosmic ray intensity from 3×10^{8} to 10^{16} e.v. can be represented by the formula (B. Peters, 1953) given below :

$$\log_{10} N(E) = A - 0{\cdot}0495\ (11{\cdot}9 + \log_{10}(E + 1{\cdot}7))^2$$

$$\begin{aligned} \text{where } A &= 6{\cdot}73 \text{ for protons} \\ &= 5{\cdot}67 \text{ for particles} \\ &= 4{\cdot}37 \text{ for CNO nucleii} \\ &= 3{\cdot}95 \text{ for nucleii } (Z \geqslant 9) \end{aligned}$$

where N(E) is the number of primary particles incident per cm.^{2}/sec./steradian whose energy exceeds E Bev.

7. **Sri B. Bhowmik**, Delhi.

He spoke on Azimuthal Variation of the Cosmic ray intensity at geometric latitude of 19°N and the existence of negative primaries.

8. **Sri B. B. Srikantan**,

He spoke on Cosmic radiation below ground.

VIII. COMBUSTION & FLAME AND EXPLOSION PHENOMENA.

Section of Physics jointly with Section of Chemistry

Chairman : **Dr. N. R. Tawde**, Bombay.

1. **Dr. W. M. Vaidya**, New Delhi, opened the discussion and spoke on the flames supported by atomic oxygen and atomic hydrogen.

2. **Srj M. M. Reddy**.

He spoke on Combustion in oscillating fuel/air mixture.

3. **Prof. Vishwanath**.

He made general comments on the talk given by the previous speakers.

4. **Dr. D. Sen**.

He spoke on the stability and structure of slow burning gaseous flame.

5. **Dr. N. R. Tawde**, Bombay.

He dealt on the spectral study of some hydrocarbon flames.

IX. RECENT ADVANCES IN THERMO-DYNAMICS.

Section of Physics jointly with Sections of Chemistry and Mathematics.

Chairman : **Dr.N. R. Tawde**, Bombay.

1. **Dr. B. N. Srivastava**, Lucknow, opened the discussion and spoke on the application of thermodynamics to chemistry.

2. **Dr. F. C. Aulick**, Delhi.

He spoke on thermodynamics and the Partition Theory of Numbers.

3. **Dr. R. N. Rai**, Delhi.

He spoke on sagar's theory.

4. **Dr. V. P. Thiruvenkatachar.**

He spoke on the thermodynamical theory of information.

X. TITANIA AND TITANIUM.

Section of Chemistry jointly with the Section of Geology and Geography.

Opening Remarks by the *Chairman* : **Dr. U. P. Basu** (Calcutta).

Titanium is one of the most plentiful metals in the earth's crust and has good many uses in industrial fields. Though not much heavier than aluminium, titanium is as strong as high-grade steel. Its resistance to corrosion is great. A tiny mixture of oxygen or nitrogen makes the metal brittle and extremely difficult to machine. If it could be produced in pure form on a commercial scale it might extensively be used in ship building, motor cars, railway wagons, aircraft and housing. Difficulty lies in the problem of smelting and getting the non-brittle metal.

Ilmenite ($FeO\ TiO_2$) and rutile (TiO_2) are the chief ores. The former is found in abundance in Travancore beach sands; ilmenite is also located in Rajputana States. India exports more than 260,000 tons of ilmenite per annum. There are bright prospects for the extraction of titanium and for the preparation of its salts. Research into the properties of titanium is going on and its many new uses are being discovered from time to time.

1. **Dr. S. S. Bhatnagar** (New Delhi) opened the discussion.

In his talk he discussed in some detail the various processes of producing titanium from the ores and the possibilities of manufacture of this metal and its compounds in India.

2. **Dr. M. S. Krishnan** (Calcutta).

Titanium is one of the commoner elements in the earth's crust as it stands ninth in the order of abundance. It forms about 0·63% of igneous rocks. It is not found in the elemental stage but as oxides, titanates and silicates. Some of the minerals are very resistant to weathering and are found as constituents of residual deposits like sands, laterite and bauxite. Modern inorganic analyses of rocks always record the quantity of titanium present, in the form of TiO_2.

The most important titanium mineral, especially from a commercial point of view, are rutile, ilmenite, titaniferous magnetite, sphene and perovskite. Numerous minerals contain a small amount of titanium and several of them are titano-silicates.

The most important titanium deposits of India are the beach sands of Travancore and parts of Madras and Bombay coasts. Commercial ilmenites derived mostly from sands contain 45 to 60% TiO_2 though the theoretical TiO_2 content will be about 53%. The mineral is derived from the charnockites and gneissic rocks forming part of the Archean complex of the Indian peninsula. The sands have been concentrated along the beach by wave action. No reliable estimates of the quantities available have been made but it is thought that the ilmenite content of the Travancore sands may be of the order of 250 to 300 million tons. The mineral is being worked in two groups of localities but there are other deposits on the eastern coast of Madras which have not yet been exploited. Some deposits are also known along the Ratnagiri coast of Bombay and along parts of the Orissa coast.

Crystalline ilmenite is found in some quantity near Degana in Jodhpur and Kancharia in Kishengarh, in Rajasthan. The laterites found in many parts of India, especially those derived from the Deccan trap, are rich in titanium oxide, running on an average to 9 to 12% and occasionally to 14%. This is recoverable in the Bayer process of manufacture of aluminium.

For many years past India was the leading producer of ilmenite in the world. In recent years the production has been between two and three lakhs of tons but during the last few years new deposits of large magnitude are being developed in the U.S.A. and Canada.

3. Dr. J. C. Ghosh (Kharagpur).

He discussed in detail the physical properties of this metal at ordinary and higher temperatures.

4. Dr. G. I. Finch (Poona).

He stated that the inactivity of this metal at lower temperatures was due to the formation of an oxide film. This crystallised at higher temperatures and the cracks thus developed resulted in making the metal active above 500° or so.

5. Dr. J. Gupta (Poona) (In Absentia).

A process for obtaining Titanium dioxide from bauxite sludge through the tetrachloride has been worked out on a laboratory scale in the National Chemical Laboratory. Hydrolysis of the tetrachloride was much quicker than sulphate, and it gave the dioxide in the pure rutile form. The acid liberated by the hydrolysis was used to leach the sludge at 80-90°C and upgrade its titania content to about 45%. The upgraded sludge was made into briquettes with charcoal and molasses and chlorinated at 700°C to give the crude tetrachloride which was used directly for hydrolysis.

Experiments on chlorination have so far been carried out only with the Bauxite sludge of the Aluminium Corporation of India, Asansol. Since much of iron and alumina are removed in the leaching process, the factors of efficiency of the chlorination process on the chlorine basis and on the titanium basis, 50·2% and 88·0% respectively, are fairly high. The efficiency of recovery of the dioxide from the tetrachloride through hydrolysis is 95%.

Encouraged by good reports from the Government Test House, Alipore, a pound of the material has been sent to each of a dozen paint manufacturing firms in India, both Indian and foreign, for examination and report.

The chief difficulty experienced by us at present is concerning grinding and sieving of material. It is well-known that a proper method of grinding, *e.g.*, grinding in a ring roller mill, greatly improves the pigment characteristics of the dioxide.

XI. PROBLEM OF FAT METABOLISM.

Section of Chemistry jointly with the Sections of Physiology and Medical and Veterinary.

Opening Remarks by the *Chairman* : Dr. U. P. Basu (Calcutta).

"Rinang kritwa ghritang pibeth", *i.e.*, take clarified butter (ghee) even by borrowing money, is an ancient saying in this land. As a matter of fact, fat reduces the bulk of our food for meeting the daily calories. It also enters to some extent into the composition of basic protoplasm. We find fat in the yolk of the egg, round the embryo in seeds of plants and in the adipose tissues of animals. Fat to be consumed must, however, contain certain types of fatty acids for proper absorption and utilization. With the trends of modern knowledge other questions arise : What advantages are there of the hydrogenated fat over the natural glycerides, how the milk fat is being formed in the animals, and whether adjuvation of vitamins is essential for proper metabolism of fat.

1. Dr .B. C. Guha (Calcutta) opened the discussion.

Co-ordinated researches conducted in four different laboratories have not shown any deleterious effect of Vanaspati as compared with the non-hydrogenated groundnut oil and ghee. Ghee, however, appeared to give slightly better growth in the rats.

2. Dr. P. S. Sarma (Madras) : *The influence of Vitamins in Fat Metabolism.* The influence of the various members of the vitamin B complex on fat metabolism has been briefly reviewed in the light of recent investigations on the subject and an account has been given of the observations at the Biochemistry Laboratory, University of Madras, dealing with the role of vitamin B_6 on conversion of oleic to linoleic acid and that of biotin on the desaturation of saturated fatty acids. Estimations of cholesterol during biotin and inositol deficiency have also been carried out. Several interesting observations have been recorded which indicate the importance of these vitamins in fat metabolism.

3. Dr. G. C. Esh (Calcutta) : *Parenteral Fat Nutrition.*

For a complete and adequate parenteral nutrition, proper supply of calories has been a problem facing the medical practitioners not only for meeting energy requirements but also for the maximum utilization of amino acids or proteinous materials. Fat, in this respect stands a unique position because of some of its physical and chemical characteristics. It is not only calorically rich with an energy value of 9 calories to the gram, when administered parenterally it is not excreted through the kidney and consequently is not lost significantly during or after administration. Emulsified fat particles do not exert an osmotic effect and even when injected in high concentration they are not injurious to veins. Moreover, fat emulsions can be prepared at the psysiological pH and can be administered in a relatively small volume of fluid. It is possible to provide even 1600 calories a day in a fat emulsion alone.

Various investigations undertaken at different laboratories particularly in U.S.A. during the last few years both over animals and human subjects tend to indicate that isotonic fat emulsions stabilised with suitable emulsifying agents can be fed parenterally to patients whenever it is necessary with considerable success. That such parenterally administered fat is properly utilized has been shown by using various criteria as gain in weight, total carcass analysis for fat, changes in respiratory quotients, rise in blod ketones following fat administration, reversal of negative nitrogen and potassium balances and from radioactive tracer studies. No evidence of irreversible damage either in the kidney or liver from such infusions of fat has been observed. Though such feeding of fat seems to be full of promise, before it can be released for general use further work regarding the successful preparation of fat emulsions completely free from pyrogen like reactions and vasomotor disturbances often associated with its use, are necessary. Studies on the effects of fat infusions for longer periods are also desirable before they can be recommended for safe use.

4. Dr. K. Mitra (New Delhi) (In Absentia) : *Metabolism of Saturated and Unsaturated fats.*

Classical experiments carried out by Burr and Burr and the subsequent investigations have proved that with the lack of certain indispensable fatty acids the smaller animals do not in some cases survive long periods; growth is definitely retarded, cutaneous eye and lesions appear. All these disturbances can be cured and the animals maintained in good condition if small amounts of linolenic and arachidonic acids are added to the diet; linolenic, decosahenenoic and other acids may improve the animals but fail to cure the lesions completely. Fewer studies have been made on human subjects bearing on the relation of unsaturated fatty acids. Studies carried on infants and children on a fat free diet have failed to adduce definite evidence of any clinical syndrome. It may be mentioned, however, that the duration of sustenance of a low fat diet with human subjects carried up uptil now is very short compared with length of time necessary to produce distinct symptoms in experimental animals. It has been observed that addition of fats rich in linolenic and archidonic acids to the diet of eczematious patients has definitely improved the skin affection in a certain percentage and cleaned the skin condition completely in others with simultaneous rise in iodine number of serum fatty acids.

Paradoxically enough the great abdominal and subcutaneous storage depots in the body consist mostly of glycerides of palmitic, stearic and oleic acids and so does the fat present in foods. Liver plays an important part of fat metabolism. Ordinarily iodine value of liver fat is higher than that of fats in the body depot. Liver also possesses a lipotropic action. With the exception of the so-called indispensable unsaturated fatty acids, not much difference can be seen in the nutrition properties of saturated and unsaturated fats. Unsaturated fatty acids, however, contain double and trible linkages which permit of increased chemical reactivity.

Fats in animals have a peculiar characteristic of their own. They may be softer as in beef or little firmer as in the case of mutton fat. This characteristic, however, can be modified if the animals starve and then lipids containing a particular type of fatty acid are included in the diet.

On the whole the position seems to be that certain amount of fat or rather unsaturated fatty acids are necessary for maintenance of good health.

5. Dr. K. P. Basu (Bangalore) (In Absentia) : *Synthesis of Milk Fat.*

Hilditch had postulated that short chain fatty acids of milk fat of ruminants arise by degradation of oleoglycerides. Recent experiments with isotopic acetic acid in which the carboxyl carbon was the isotopic carbon-14 (CH_3COOH) have, however, shown that the lactating mammary gland builds up saturated fatty acids in which alternate carbon atoms are radioactive, showing conclusively that acetate is a major source of carbon for fatty-acid formation in the udder and that the short-chain acids are intermediates in the formation of long-chain acids by stepwise chain elongation at the carboxyl end by addition of an acetate group. Glucose has been shown to be as good a source as acetate and probably acts via acetate. Unlike blood of other animals which contains very little acetic acid, ruminant blood contains as much as 12 mgm. per cent acetic acid but is lower in glucose content. Milk fat may have a dual origin—part synthesized in the udder from small molecules and part entering the gland from the blood and there undergoing chain-shortening. This chain-shortening need not necessarily involve chemical degradation of the oleo-group but might result from replacement of oleo-groups by butyro—etc. by the process of acyl interchange.

Complete synthesis of adequate substitutes for milk fat is a difficult undertaking. Invention by Mége Mouriés towards the end of the 19th century of margarine, a butter substitute first made from beef fat and later from a mixture of fats including lard, vegetable oils, etc., was a landmark and it was regarded as synthetic.

Synthesis of glycerine from propylene (Friedel and da Silva, 1872) and of fatty acids by heating paraffin wax with sodium carbonate in an autoclave at 170°C and blowing in air (Shaal, 1885), indicated the possibility of making synthetic fats. Virtually complete synthesis, from carbon monoxide and hydrogen was achieved in 1930 by the oxidation of Fischer-Tropsch waxes to fatty acids, which could be esterified with glycerine from propylene. During the recent war, substantial quantities of margarine substitute were produced in Germany, notably at Witten in the Ruhr, where 150 tons a month were made at the Deutsche Fettsaure plant. In appearance and taste, the product was very similar to oleomargarine. It differed primarily in that the fatty acids used contained molecules of both odd and even numbers of carbon atoms, whereas natural fats possess only even numbers.

The procedure adopted at Witten was to react C_8 to C_{20} acids with glycerine in the presence of 0·2 per cent of metallic tin at 392°F and 2 mm. pressure. The resulting triglycerides were washed with acid to remove the catalyst, neutralized, treated with active charcoal and bleaching earth, filter-pressed, steamed at 392°F under 2 mm. pressure, emulsified with 20 per cent water and vitamin concentrates and finally chilled and milled.

Since the war, development work has continued, notably in America. Petroleum waxes, as well as Fischer-Tropsch waxes, have been subject to extensive treatment to eliminate undesirable branch chains and generally to yield, on oxidation, fatty acids closely akin to those contained in natural oils and fats.

6. Dr. N. N. Godbole (Jaipur).

Talking of the Vanaspati, he drew attention to the following points : (1) its melting point; (2) its glyceride structure; and (3) its relation to human fat as a reserve (depot fat). The question of the formation of iso-oleic acid was also discussed. Reference was made to the experiments carried on with Vanaspati on rats in view of the fact that the normal diet given to a rat had no meaning. He suggested that parallel experiments should be done with three groups of men, one fed on pure ghee, one on Vanaspati and one on pure oils. So far as the testing of the adulteration of pure ghee by Vanaspati is concerned, he said that the Sesamol test as laid down by the Government standard was absolutely safe and reliable. The addition of any colour to Vanaspati was superfluous, expensive and purposeless. Referring to erucic acid, he said that the melting point of this acid was below that of the body temperature (36-37°C), which was the limit put down for Vanaspati. Any fat with a melting point of more than this temperature would create disorders in the digestion of the human system and would pass away as a ballast. He made a distinction between "digestible" and "assimilable" as is made in the case of animal proteins and vegetable proteins.

7. Dr. S. V. Puntambakar (Dehra-Dun).

I agree with most of the views so well expressed by Dr. Godbole. I, however, have my differences with him on what he has said about colouration of Vanaspati to prevent its use in adulteration of cow or buffalo ghee. I agree that addition of Sesame oil to Vanaspati by law would considerably help Chemists and even other experienced technical persons to find out adulteration by the Baudouin's test. But there are no such persons nor centres of testing in our innumerable towns and villages where tons of Vanaspati and adulterated ghee are sold side by side to the huge majority of non-technical and illiterate public who can never perform the test, however simple it might be. If and when they come to that level of technical development of performing the test as supposed by Dr. Godbole then there will be no need for Vanaspati colouration.

The removal of any colour including carotene and chlorophyll by decolourizing agents is no doubt simple in a chemical laboratory where activated charcoal and fine filteration media are at hand. But the question is, can it be done by a Sofisticator, effectively, on a small scale, outside a laboratory? On the other hand if practised on a large scale the adulteration can easily be detected for obvious reasons.

In spite of the compulsory addition of Sesame oil to Vanaspati, adulteration of cow or buffalo ghee is very largely in vogue at present. So much so that pure cow ghee is nowhere available in the open market. Therefore, in my opinion internal colourant for Vanaspati, like Sesame oil used at present, will not be able to stop adulteration and, therefore, external colourant like Carotene and Chlorophyll —and Chlorophyll is the best among natural harmless colouring agents so far found—is highly necessary.

8. Dr. S. Banerjee (Calcutta).

Dr. Godbole has remarked that there is nothing as normal diet of a rat and results based on experiments carried out in rats should not be applied in man. Diets on which rats grow and reproduce normally are considered as normal diets for rats and this has been found out by biochemists who use rats as experimental animals. Rats are indispensable for biochemical investigations. New vitamins remained undiscovered if rats were not used as experimental animals. Results of researches on rats have been well utilised in the study of human nutrition. Biochemists, therefore, will not agree with the observations of Dr. Godbole.

Dr. Godbole thinks that fats with melting points higher than the body temperature is useless for human beings. These fats may be digested but cannot be assimilated. These observations are far from truth. Fat, if digested in the gastro-intestinal tract will be absorbed and assimilated. The absorbed fat is desaturated in the liver as a normal process of fat metabolism and a fatty acid with a higher melting point, if taken, will be transformed into a fatty acid with a lower melting point. Nutritional superiority of a fat may not depend on the melting point of the fat consumed.

In problems such as fat metabolism research workers in different lines such as biochemists, organic chemists and physiologists should work and discuss in collaboration. If that is done the confusion of ideas as manifested by Dr. Godbole's observations would disappear.

9. Dr. S. C. Seal (Calcutta).

I would like to know if any systematic work has been done on the effect of ingestion of hydrogenated fat upon the metabolism of calcium. In the statistical analysis of certain experimental results I remember it was found that children maintained on hydrogenated fat were depleted of their calcium to the extent more than they actually consumed. If it is so, they will probably get rickets if they are fed on hydrogenated fat only for a long time. The effect on calcium metabolism is therefore an important one.

XII. ION EXCHANGES.

Section of Chemistry, jointly with the Section of Agricultural Sciences.

Opening Remarks by the *Chairman* : DR. U. P. BASU (Calcutta).

Ion exchange is a phenomenon where some substances remove ions from solutions and liberate equivalent amounts of other ions in their stead. Certain silicates, synthetic organic substances and even some other geological materials possess the power of exchanging ions. Extensive developments have taken place in the industrial use of these ion exchangers; they are produced in tons and are used for varied purposes.

Their performance is dependent on various other factors and they are playing a significant role both in nature as well as in laboratories as reagents for titration, buffering and catalysis, as adsorbates, and as a physico-chemical technique for the determination of ionic charge, ionic concentration, ionic and molecular size. Besides, the subject has its own interest from the standpoint of fundamental enquiry.

1. DR. J. N. MUKHERJEE opened the discussion.

He gave a general survey of the exchange phenomenon and its applicability in diverse fields.

2. DR. B. CHATTERJEE (Sibpur) : *Ion Exchange in Soils.*

The 'clay complex', consisting of organic and inorganic ingredients, is the seat of ion exchange in soils. The inorganic part is composed of one or more secondary aluminosilicate minerals, namely, kaolinite, montmorillonite and illite. 'Broken-bonds' account for the exchange capacity of kaolinite. Isomorphous replacement within crystal lattice and presence of 'broken-bonds' account for this property in montmorillonite and illite. The existence of 'broken-bonds' in clay minerals has been established by studying their reactions in non-aqueous solvents.

The negative charge of colloidal clays is balanced by positive ions. A part of these ions is osmotically active or 'mobile' while another part is inactive or 'bound'. The mobile ions and then bound ones are exchanged for cations of added electrolytes. The balancing ions are held by clays with different bonding energies. An equilibrium exists between mobile and bound ions and between exchangeable ions and lattice ions.

Hydrogen clay is a heteroionic clay in that hydrogen and aluminium (magnesium) constitute the exchangeable ions. Ion exchange in soils is governed by the nature and amounts of clay minerals present and the ions concerned. The Organic constituents of clay complex resemble their inorganic counterparts in exchange behaviour but possess this property to a much greater degree.

3. DR. H. A. SHAH (Poona) : *Synthesis of Ion Exchange Resins and their applications.*

Even though the phenomenon of Ion Exchange was first observed by way a century ago, rapid progress in this field was only possible after the discovery of synthetic Ion Exchangers by Adams & Holmes in 1935. In the last few decades, Ion exchange has taken its place among the common chemical unit operations that are of value in processes of isolation and purification.

Before Ion exchange resins could be applied to a large number of industrial processes, it is necessary to develop methods of synthesis from mostly indigenous sources.

At the National Chemical Laboratory, Cation Exchange resins have been made from a number of different products. For example, by the condensation of phenol or mixture of phenol and cashewnut shell liquid, sodium bi-sulphite and formaldehyde, cation exchangers containing methylenesulphonic groups have been prepared. By the gelation of cashewnut shell liquid or bhilawanshell liquid with either sulphuric acid or formaldehyde and further sulphonation of the product, high capacity cation exchangers containing both sulphonic and carboxylic type groups have been prepared.

The synthesis of anion exchangers presents some difficulty as the intermediates, polymines or guanidines are not easily available. However by the condensation of phenolic type compounds with formaldehyde ammonium salts suitable anion exchange resins have been prepared.

The application of Ion exchange to de-ionisation of cane juice results in almost colorless juices with a purity rise of seven to ten units. This will eliminate the formation of black-strap molasses and will give an edible syrup instead. The deionisation of glycerin and brackish waters has also been studied. Another use of Ion exchange resins as catalysts is in the Pechmann condensation.

4. Dr. K. S. G. Doss (Kanpur) : *Ion Exchange in Soils.*

The data of Dr. Chatterji appears to indicate that whereas the addition of LiCl to clay sols does not appreciably affect the pH, it does affect the acidity of the ultrafiltrate. This is a little unexpected, as the pH should necessarily be appreciably affected if the ease of passage through the ultrafilter membrane is materially affected.

I would suggest that the use of an ultracentrifuge (or a sufficiently high speed centrifuge) instead of the ultrafilter may perhaps elucidate the above paradox.

5. Dr. Hirendra Nath Das Gupta (Dhanbad).

For suspension of Kaolinite, electrolyte is added, which decreases the viscosity. If such suspension be filtered, the residual clay is found to possess plasticity. How to account for this plasticity, in view of the fact that the particles are charged alike?

The speaker wanted to explain on the basis of the fact that water molecule is polar. But Dr. Mukherjee did not like to have further discussion as the problem was much complicated.

6. Dr. S. K. Mukherjee (Calcutta) : (In Absentia) : *Ion Exchange in Clays, Clay Minerals and Synthetic Resins.*

The recent approach to the interpretations of cation and anion exchange in clays and clay minerals through their crystal chemistry has been in many ways fruitful. Clay acids contain hydrogen ions in an exchangeable form, which react in stages, just as a polybasic acid does. Kaolinite as a dibasic acid, and montmorillonite (also mica) as a tribasic acid have now been well established. In the case of bentonites the three levels of interaction have been verified by means of exchange isotherms of the colloidal salts, but are more clearly demonstrated by potentiometric titrations in non-aqueous media. An extension of the electrochemical studies to non-aqueous protolytic media has already shown considerable promise. These different affinities of H+ or other exchangeable cations are correlated with the crystalline structure of the clays.

Heteroionic clays have been investigated to further demonstrate the presence of different categories of exchangeable cations. This difference in exchangeability is also clearly manifested in the study of ionic exchange by means of mixed electrolytes. In the latter studies are noticeable strong evidences of ionic antagonism in varying degrees.

Anion exchange in clays, although reported by many workers, is not a very clearly understood process. Theoretically, the OH ions associated with either $Al^{3}+$ or $Fe^{3}+$ or possibility $Mg{+}{+}$ are likely to take part in anion exchange. However, anions such as phosphate or fluoride may attach themselves directly to the lattice $Al^{3}+$ and/or $Mg{+}{+}$ ions, and if the combination is strong enough the whole lattice structure is destroyed, and alluminium phosphates of more or less definite crystalline character are formed.

A recent interesting application of the ion exchange properties of clays has been made in the preparation of cation reversible electrodes, just as the glass electrode is for H+ ions alone.

There is hardly any branch of chemistry which does not make use of the exchange properties of synthetic resins. The latter may be made to function in a wide variety of desired ways according to the nature of the exchanging or functional groups.

Thin membranes prepared from the cation exchanging resins are cation reversible just as the clay membranes are, and what is more, the membranes made of anion exchange resins are anion reversible. The usefulness, therefore, of these membranes for the measurement of the activity of cations and anions, either in solutions or on the exchanging surfaces cannot be too strongly emphasised.

7. **Dr. S. P. Raychaudhuri and Dr. B. B. Roy** (New Delhi) (In Absentia) : *Clay Minerals and Their Importance in the Classification.*

The physical and chemical properties of soils ultimately depend upon the nature and amount of clay mineral contained in them and it is thus essential that the classification of soils should primarily be based on the mineralogical make up of the clays. In the present paper the characterisation of the minerals present in clays isolated from several typical soils profiles of different localities of India have been discussed and correlation of the nature of the clay minerals with these soil types made. Martmorillonite has been found to be the predominant mineral constituent in the clays from regur or black cotton soils of India. There was no variation in the mineralogical composition down the profile. In laterite, lateritic and red soils the chief mineral constituent is kaolinite. Soil from Delhi occuring within the Jumna alluvium region has illite as a major constituent of the clay, its proportion decreasing gradually with depth. The other constituent is montmorillonite, the proportion of which increases correspondingly. Soil from Karnal (Punjab) also occurring within the Indo-Gangetic alluvium belt, has, however, kaolinite as the main constituent of the clay fraction, but the top horizon upto 26 inches also contains some montmorillonite minerals. In both these cases the montmorillonite-illite clay minerals in the profiles have probably originated from the wind borne dusts from the adjacent Rajputana desert. It also appears likely that the non-occurrence of magnesium in the Sambar Lake water is due to the disappearance of magnesium from wind borne sea salt for conversion of illite into montmorillonite occurring in the clay complex.

8. **Dr. S. M. Sircar** (Calcutta) (In Absentia) : Ionic exchange in plants.

Consequent upon the unequal absorption of ions by living plant cells ionic exchange between the exterior solution and the cell is an important feature in the absorption and accumulation of salts by plants. The absorption of salts is a two phase process, the two phases being related to different conditions in the cell. The first phase is interpreted in terms of the establishment of ionic equilibrium between the cell and external medium involving exchange of ions and is determined by the principles of Donan equilibrium and law of mass action. The second phase is mainly related to the metabolic activity as indicated by respiration of the cell. As a result of respiration H+ and HCO_2 are produced in the tissue and cation entry takes place by the exchange with an equivalent quantity of H+ and anion with HCO_3 ions. Accumulation may also result from the exchange with some organic ions produced as metabolic waste products.

In recent years interesting developments have been noted between salt absorption and respiration and protein synthesis. Since ion absorption by plant tissue takes place by way of exchange reaction betwen the culture medium and the tissue offering a high resistance due to its colloid components and the absorption of cation to some extent independent of the uptake of anion it appears that there is some driving force and carrier substance involved in the transport of ions from the exterior to the cell sap in the vacuole through the intervening cytoplasm. What the nature of this carrier substance is is a matter of speculation. As salt absorption is closely related to the cytochrome oxidase system in respiration (Lundegardh), one possibility is that the mitochondria or microsomes (protoplasmic particles) act as the ion carrier since cytochrome components of respiratory system are carried on mitochondrial particles. The other consideration (Steward and Street) is that amino acids or some energy rich phosphorylated nitrogenous components in the protoplasm might serve as carried for ions in view of the fact nitrogen absorption was found by the author (*Ind. Jour. Agri. Sci.*, 1943) and others (Steward and Street, and Brooks) to be accompanied by increased respiration rate, aminoacid and protein content.

9. **Shri R. P. Puri and Shri P. K. Banerjee** (Jealgora) : Ion-Exchangers and their applications with special reference to Zeo Karb Prepared.

The phenomenon of Ion-Exchange was first discovered about a hundred years ago, but recent developments are only seventeen years old. Historically, the siliceous ion-exchangers are the oldest, followed by the carbonaceous ion-exchangers and the resinous materials of the present age. The two types of ion-exchange reactions, one involving the cation and the other involving the anion, have been discussed and the nature of the exchange reaction analysed.

The different types of ion-exchange materials have been discussed with special reference to the Zeo-Karbs prepared at the Fuel Research Institute from samples of coal. The optimum conditions for preparing the Zeo-Karb from coal with improved exchange capacities (by the straight sulphonation method) have been studied and an improved method discovered. The application of ion-exchangers in the different fields, *e.g.*, water softening, de-ionisation, desalting, etc. are then discussed and special reference is made to the pilot water-softening plant using F.R.I. zeo-karbs installed at the Fuel Research Institute.

10. SHRI K. V. S. SATYANARAYANA, SHRI N. SEN AND SVRI V. S. SUBRAMANIAN (New Delhi) (In Absentia) : Mineralogical make up of sands and clays of some soils of Rann of Cutch.

Kaolinite, montmorillonite and illite, ,are the main groups of clay minerals present in soils and marine sediments. The interchange-ability of minerals under certain conditions are also known. The mineralogical examination of fine sands in three profiles situated at different places in the Rann of Cutch showed that the sediments reaching the areas differed in degree and kind of the mineral suite. From a comparison of the accessory minerals in the Rann sediments and the drainage areas it was concluded that in the direction south to north the sediments indicate a less basaltic and more non-basaltic nature. The clays showed a high silicasesquioxide and silica-alumina ratios and cation exchange capacity of the order normally attributed to illite group of clay minerals. The conditions that favoured the formation of mainly illites and probalbe presence of authigenic and primary unweathered minerals are discussed. Attention has also been drawn to the fact that the presence of illite may be an indication of restricted conditions of soil development.

11. SRI K. SEN GUPTA (Suri; Birbhum) : Equilibrium Studies on Ion Exchange between Adsorbents.

Ion exchange between adsorbents saturated with different cations of equal valencies has been studied. Cation exchangers like Amberlite (A) and Ion X (X) of different particle size were mixed and shaken for days. Cationic constituents at equilibrium in the two were estimated after separation by wet sieving. Exchange constants (K) were obtained assuming mass action, *e.g.*, for $(X)NH_4 + (A)Na \rightleftharpoons (X)Na + NH_4(A)$, K calculates to 1·46. The constants were also calculated from reaction constants (K_X, K_A) of the adsorbents and neutral salt solutions :

$$K_X = 0{\cdot}793 \text{ for } (X)NH_4 + NaCl \rightleftharpoons (X)Na + NH_4Cl$$
$$K_A = 0{\cdot}532 \text{ for } (A)Na + NH_4Cl \rightleftharpoons (A)NH_4 + NaCl :$$
$$[(X) \text{ particles} < 0{\cdot}1 \text{ mm.} + (A) \text{ particles} > 0{\cdot}5 \text{ mm.}]$$

Algebrically $K = \frac{K_X}{K_A}$; Experimentally also the observed (K) and calculated $\left(\frac{K_X}{K_A}\right)$ values of the exchange constants agree within the limits of experimental error for systems like NH_4Na, Ca-Ba, NH_4-K.

XIII. LAND UTILISATION SURVEY.

Section of Geology and Geography, jointly with Section of Agricultural Sciences.

Chairman : PROF. N. L. SHARMA (Dhanbad).

1. DR. S. P. CHATTERJEE (Calcutta) opened the discussion. He dealt with the following aspects :

The necessity of undertaking a land use survey was pointed by me in my presidential address before the Section of Geography in Madras in 1940. The topic was also discussed in Nagpur and Delhi sessions of the I.S.C., but nothing tangible has come out of these discussions. Meanwhile things are moving fast in the West. The Land Utilization Survey of Great Britain has been completed, while it is being conducted by the help of geographers as in Canada, Italy, W. Germany, etc. Further a permanent commission on World Land Use Survey appointed by the International Geographical Union is functioning at the moment under Prof. Van Valkenburg of U.S.A.

Now that the Government of India have finalised the Five-year Plan, and have given priority to agriculture it is all the more reason to go ahead with the production of land use maps. Conditions in India do not allow too much reliance on sample surveys and statistical methods, though I quite agree that it will not be an easy task to undertake a land use survey of such a big country as India. For certain areas some land use statistics collected by village patwaris is available, but I do not know how much of it is guess work. Cadastral survey maps (16 inches to one mile) are available and may serve as our base maps.

Survey of India one-inch toposheets are quite inadequate as they only show all kinds of cultivated areas by yellow, and wooded areas by green.

I suggest that the existing University departments of geography interested in land use surveys be given financial assistance by the State and Central Government and by the I.C.A.R. for carrying out land use surveys. A geographical branch should be attached to ministries of Agriculture in the State as well as Centre to carry out land utilisation survey work. In a vast country like India the task will be simpler if we take one-inch to mile toposheets as our base maps, or still easier if mapping is done on a scale of one to one million. But if this does not bring out results of practical value we may adopt the Canadian method by dividing the country into a number of map regions and then surveying typical and atypical regions. We may also take the help of air photographs, and such photographs, if already taken, as by the D.V.C., should be made available to us for preparing land use maps.

Land use survey has been recently carried out by us in Howrah District, W. Bengal. It took us nearly one year to complete the field work, covering an area of 600 square miles. A mosaic of 16 inch maps was prepared by plotting field data in each plot. These were reduced photographically, and are now being printed for us by the Survey of India on a four inches to one mile scale.

2. **Dr. V. L. S. Prakasa Rao** (Madras) :

There is almost universal agreement among experts both in India and abroad that land classification provides a rational basis for chartering the future use of land. It is also recognised that land classification is useful as a basis for judging the optimum geo-economic conditions, hence also the geographic limits within which given policies of land use may be adopted. But land-use survey must precede land appraisal and classified both logically and chronologically.

At the International Geographical Congress held at Lisbon (April, 1949), Prof. S. Van Valkenburg proposed a gigantic scheme for a "A World Land Use Survey" and a Commission which was appointed by the International Geographical Union brought forth a report which rightly emphasised on recording the present use of land in all parts of the world on a uniform system of classification and notation with such amplification as may be necessary locally. Such an inventory of land use is 'factual, basic and objective'. The World Land Use Survey came into being on 1st January, 1951 with the establishment of the Old World Divisional Headquarters in London. The immediate intentions are stated to be (1) carrying out a few pilot surveys to test the validity of the classification drawn by the Land Use Commission and (2) preparing specimen sheets 1 : 1,000,000 scale and other scales together with explanatory memoirs.

In India Land Use studies are made by different institutions. The Imperial Council of Agricultural Research is directly concerned with agricultural and soil problems. Land Classification work is being done in the Lift Irrigation Project areas (Bombay) and the Damodar Valley. The National Sample Survey also includes Land Utilisation Survey. At the invitation of the Government of Bengal, the Geography Department of the Calcutta University under the directorship of my teacher Prof. S. P. Chatterjee surveyed the Howrah District (600 square miles) with a view to finding out the extent of land potential for the settlement of refugees. This is really an example to the other Universities and Provincial Governments, in India. In the Geography Department of the Madras University every year some 10 students (Honours and Post-Graduate) conduct geographical survey of the villages near about Madras or their native villages and prepare land use and other maps on 16"—1 mile scale. Each student takes up one village for his survey. This year the scheme of the World Land Use Commission with some modifications is adopted for some of the villages surveyed by the present batch of students. (A few maps are exhibited).

In the opinion of the writer, Land-Use Survey in India should follow a four stage pattern :—

Stage (1)—*Collection* of the existing data for every field on both general and specific categories of land use. This information is available in the registers (maintained by the village accountant) known by different names in different provinces, *e.g.*, *adangal* (Cultivation account) in Madras. In the case of non-government villages which are only block-surveyed the information is available on block basis. It is doubtful whether there is any country in the world where recorded information on field basis and large scale field maps are available as in India.

Stage (2)—*Mapping* on the basis of the above data on the scale 16"—1 mile which can be later on reduced to a common scale. A general land use map can also be compiled basing on 1"—1 Mile topographical sheet (old edition which is coloured) and the following land categories can be recognised : (*a*) Forest land, (*b*) Scrub and open jungle, (*c*) unproductive land, (*d*) marsh, (*e*) cultivated land, (*f*) Mixed use and (*g*) Settlements.

A base grid at 1′ minute or even 30 seconds interval may be adopted for this purpose.

Stage (3)—*Field Work* : Mapping and collection of data; verification of the land-use inventory by spot observations and collection of data pertaining to land-use by enquiries. This stage involves a number of reconnaissances and traverses. In view of the complexity of agricultural practices and seasonal variations in land-use, it becomes necessary for the field worker to do field mapping or verifications in different seasons, say in coastal Andhra, in July, September and February in non-deltaic lands and July and February in deltaic lands.

Stage (4)—*Analysis* : This stage in addition to the collation and analysis of the whole data also consists of the preparation of a number of maps relevant to the survey, *e.g.*, Irrigation and soil maps (source—a special register known as diglot or Village Memoir) and a map of land-holdings showing fragmentation and scattering (Source—Field Measurement Book (F. M. B.) and Account No. 10-1).

All the above stages can be resolved into two : (1) the Library and Laboratory and (2) Feld Work stages. It is essential that Library work should precede field work, and only then one's sense of observation becomes much sharpened and he works with relatively little lost motion. Aerial mosaics if available will be most useful to start with.

The success of land-use survey in India depends on the number and quality of field workers and facilities for field work. An understanding among the different scientists concerned as to the scheme of work is even more important.

Geographer is primarily devoted to the study of locational and spatial aspects, and identifies the relationships between positions of objects and events in space. Then, according to this concept, the Geographer can contribute to :

(1) Exploratory work and portrayal of the distribution of land-use types in map form according to modern standards of cartography.

(2) Aereal classification and quantitative analysis of land-use data and

(3) Identification and interpretation of the extent and quality of land-use types.

3. Dr. H. L. Chhibber (Banaras) :

Problems of land are certainly more complex in India which have been rendered still more complicated with the partition of the country. The wheat granary of the Punjab, especially of the canal colonies has gone mostly to Pakistan. As a result we have gone deficit in our food resources. Likewise the supply of the basic raw materials for our important jute and cotton industries has been affected very adversely. The problem of rehabilitation of the refugees both from Western and Eastern Pakistan has added further difficulties. They have to be settled both on land as well as in residential settlements. The abolition of Zamindari would certainly require the stock of land to be taken in the light of recent developments. In this connection the Bhoodan Yajna of Shri Vinobha Bhave has also to be taken into account.

The allocation of the cultivation of cash crops like sugar cane, etc. will have to be adjusted in the light of new requirements and developments as the author has observed in certain years in some districts of Uttar Pradesh that the surplus cane not purchased by the mills had to be burnt standing in the field. Such a wastage cannot be tolerated. To solve these problems land utilisation survey of India has really become necessary. The author has divided India into the following main units for purposes of this survey. (1) The Indo-Gangetic Plains including the coastal and the deltaic plains. (2) The Himalayas may be divided into two zones : (*a*) The Siwalik and (*b*) the Middle Himalayas. Here special attention will have to be paid to the valleys of Kashmir, Doon and Katmandu. (3) The Peninsular Region and (4) The Deccan Trap Region. The author has observed the occurrence of large areas of culturable wastes in these regions and their exact location and extent can only be brought to light by actual survey.

There is of course the difficulty of maps. Even one-inch maps have been restricted lately. For such a survey maps showing each field should be available in order to carry out the work accurately and rapidly. Considering the local conditions the index under which land will have to be classified and surveyed will have to be finalised. There are several considerations in this respect. For instance, even by strippling it would be advantageous to show separately land under improved varieties or under ordinary low-yielding varieties. Likewise there should be a separate tint for showing land which could be reclaimed from ravine, usar, flood or any other type which has been lost to agriculture. But there are other factors which will have to be taken into account in solving the land and food problems of the country. If soil survey could be undertaken along with this land utilisation survey it will be further beneficial.

4. **Dr. G. S. Puri** (Dehra-Dun) :

One of the speakers has remarked about, what seems to him, the unjustified demand of forest departments to take away certain agricultural land for afforestation purposes. This afforestation programme he also admits is solely for the benefit of the agriculturist as it is designed to arrest erosion and conserve soil and water. However, I wish to draw the attention of this distinguished gathering that the Forest Department nowhere believes in unreasonably extending forests to agricultural lands, but innumerable instances can be cited to show that it is the agriculturist who has constantly been encroaching on the fertile forest areas. And when by malpractices he has ruined the land he passes it on as a gift to the forest departments. The Rajputana Desert is one such gift of the agriculturist and you will be interested to know how much the Forest Research Institute are doing to immobilise the desert. A Research Station has been recently set up at Jodhpur under the F.R.I. and the work of protection of existing vegetation, planting a long belt nearly 5 miles deep ; and experiments on the selection of right type of species for afforestation have already been started. This much is for the clarification of the remark about the Forest Department.

The State Forest Departments maintain survey parties which prepare working plan maps in which along with tree vegetation features of topography, soil and geology are also recorded. These data are of some importance in classification of forests for exploration purposes. But for detailed land use survey these maps could be further improved, bringing into these, detailed features of geomorphology, rock, soil and all types of vegetation. I have recently described this method in a paper on "The transect method in the study of plant communities in India" (Proc. 8th Silvicultural Conference, Dehra Dun, 1951). The advantage of this method is that the survey takes into consideration the study of natural vegetation associated with the soil, and evaluates potentialities of the land especially in relation to the dynamic changes that are occurring in the climatic condition of the locality.

For land use planning, it would be best if the area under study is divided into three broad soil fertility categories, viz., Best, Medium, and Poor. On poor soils, forest must always be maintained. On medium soils, a mixture of forest and pastures, and agriculture should be done only on the best soils, which will not deteriorate and get eroded under intensive cultivation. The chief criterion for classing the soil into the above three categories should be the maintainance at high level of soil fertility. The maps exhibited by Prof. Chatterjee are commendable and these could probably be further improved on the lines suggested here.

5. **Dr. V. L. S. P. Rao** (Madras) :

The technical experts must present data and the administrators would put things into effect.

About approach to the survey, the speaker is of opinion that field work should be conducted intensively. Investigations in the Laboratory must be supplemented by investigations in the field. Irrigation maps, soil maps and other relevant data must be collected.

XIV. TRAINING AND PROPER UTILIZATION OF PERSONNEL IN GEOLOGY, GEOGRAPHY, ENGINEERING AND METALLURGY.

Section of Geology and Geography, jointly with Section of Engineering and Metallurgy.

Opening Remarks by the *Chairman* : **Prof. N. L. Sharma** (Dhanbad).

A. Training.

I. In order to make our science education broader and also to raise the standard of M.Sc. in Geology, the following combinations of subjects are suggested for the I.Sc. and B.Sc. Examinations of our Universities :—

I.Sc. course :—(*a*) Physics, Mathematics and Chemistry (with short courses in Botany, Zoology and Geology).

(*b*) Botany, Zoology and Chemistry (with short courses in Physics, Mathematics and Geology).

B.Sc. course :—(*a*) Physics, Mathematics and Chemistry (with a short course on Mineralogy).
(*b*) *Geology*, Physics and Chemistry (with a short course in Calculus and solid Geometry).
(*c*) Botany, Zoology and Chemistry (with a short course on Palaeontology and Stratigraphy).
(*d*) *Geology*, Botany and Zoology (with a short course on Analytical Chemistry).

II. The present system of having a three years' or two years' B.Sc. (Honours) course in Geology, as it exists in some Universities may be abolished, as experience shows that most of the B.Sc. (Honours) candidates proceed to the M.Sc. course, facilities for which exist now in practically all the Universities. The minimum qualifications for any Geologist's post must then be M.Sc. in Geology or an equivalent Diploma in Geology of a recognised institution.

III. Admissions to M.Sc. Geology course must be limited to those passing B.Sc. with group subjects in (*b*) and (*d*) above and obtaining first class or high second class marks in Geology.

IV. There should be a University Examination for M.Sc. Part I at the end of first year of M.Sc. in the following subjects :—

(*i*) Structural and field Geology; (*ii*) Stratigraphy and Palaeontology; (*iii*) Mineralogy and Petrology; (*iv*) Economic Geology.

V. The final year for M.Sc. part II Examination must be devoted to specialisation and this may be in any one of the following groups of subjects :—

(*i*) Mining Geology, Engineering Geology and Geophysical prospecting; (*ii*) Crystallography, Mineralogy and Petrology; (*iii*) Stratigraphy, Palaeontology and Geomorphology.

VI. In both the M.Sc. Examinations, field work should form an essential feature and as such, Geological mapping, field report and a *viva voce* examination thereupon, should form a separate paper in Practicals of the final M.Sc. Examination.

VII. Pending the birth of State Surveys (as suggested below), the Central Geological Survey of India itself should set apart every year suitable areas for geological mapping, mineral survey and hydrological surveys, to be carried out by post-graduate students of various Universities who may be deputed for practical training during the two months of summer vacation. Normally, a member of staff from each University is to accompany the respective University students. The period of vacation not being a field season for the G.S.I. officers, one or two senior officers can easily be deputed to supervise the work. This will enable the Geological survey to tackle many of its mineralogical and hydrological surveys within the shortest possible time and with minimum cost.

VIII. The last fortnight of December every year, should be regarded as a period of Natural Science Tours in all Universities for the students of B.Sc. Geology class, and there should be a combined tour with students of Mining, Metallurgy, etc. to places of interest. Several institutions can join together to have special compartments reserved for the whole journey, which would be detached at the Railway stations, so that, the problem of accommodation may not stand in the way. This will give the students a broader outlook of their subject and the advantage of coming into contact with students and staff of different subjects and institutions.

IX. During the same part of the year, the Mining, Geological and Metallurgical Institute of India and the Geological, Mining and Metallurgical Society of India, should have a few conducted geological tours, each lasting for a week or so, to places of geological, mining and metallurgical interest, when the officers of Geological Survey of India or the Professors of various Universities may take the party around the area of special interest or which they have studied in detail, and thus derive the benefit of mutual discussion and experience. So far, these bodies are simply satisfied with having a few hours' meetings or excursions. Actually, very few geological excursions are held by them.

B. UTILISATION.

As no facilities exist at present in India, like those in U.S.A., for geology graduates to get training on the job, it is suggested that :

I. All companies applying for a mining lease should submit with their application a geological report by a qualified geologist.

II. All companies working any mineral deposit must have their area of lease geologically surveyed and must have a geological map of the area on 500 ft. to an inch, prepared by a qualified geologist.

III. All companies, especially those working metalliferous deposits, should maintain like a Survey Plan, a geological plan with geological sections of the underground workings.

IV. It follows from the above suggestions, that knowledge of geology must be essential for a Mine Surveyor and as such, M.Sc. in Geology should be allowed to sit for the Mine Surveyors' Examination with a few months' experience in the mines.

V. The Indian Bureau of Mines should employ as paid apprentices, M.Sc.s in Geology and thus take their help in expediting the solutions of many of the problems connected with the proper exploitation and conservation of Indian minerals.

VI. Every State should maintain its own Geological Survey as is the case in many of the States of U.S.A., and their aim should be to have a preliminary survey of every region. The Central Geological Survey of India should be a co-ordinating body and should in addition, take in hand, detailed geological mapping of the areas, investigations of the mineral deposits and proving the reserves, etc.

VII. The Geological Survey of each State, in order to expedite its Survey, should have one or more geologists working in each district or group of districts, according to the area and geological needs. These geologists should be trained first under the Ground Water Section of the Geological Survey of India and the Soil Section of the Agricultural Research Institute. The primary function of such geologists should be to make a rapid survey of the soils, minerals, and water supply of each district. They should advise through *'gram panchayats'*, the village people about the location of wells and tanks, alignment of roads and drainage, suitable clays for bricks and the characters of their farm soils. In fact, every Community Project should have a resident Geologist attached to it.

VIII. In order to expedite the whole scheme and save the cost of separate establishments, the State Survey may, for the present, be established in the Geology Departments of the various State Universities and that of District Geologists, in the Department of Physics and Chemistry of the State Colleges of each district, where facilities for analytical work on soils and minerals should be provided.

1. Dr. M. S. Krishnan (Calcutta).

Geology is *par excellence* an applied science and it is necessary for geologists to have a very good grounding in the fundamental sciences before they specialise in this subject. There is some difference of opinion as to whether geological education can be taken up in the High School or Intermediate stage but I should advocate the subject being studied systematically only in the degree or post-graduate stages. From the point of view of the employer geological education in the University should provide for sufficient practical training in addition to theoretical training in all branches as, otherwise, some time is necessarily lost in giving practical training to the geological employee. Now-a-days it is necessary for the field geologist to have a good grounding in methods of mapping, exploration of mineral deposits, engineering geology and other subjects though such grounding need not be highly specialised until the student begins specialisation in one particular branch. The geologists should have good physique as well as an aptitude for facing difficult conditions in the field. He should be trained to make accurate observations and to separate factual data from deductions. Once the facts are carefully gleaned their interpretation is a matter of experience.

At present the training given in the Indian Universities is not uniformly good. In many cases lack of adequate staff and facilities for field training are obstacles in imparting a high standard of practical training under field conditions. It is suggested that the periods of vacation be used for field training courses. Apprenticeship in mines would be very useful in imparting knowledge of methods of prospecting, sampling mining, etc. The student should have a good knowledge of mapping for different purposes and under different conditions but in all cases adequacy of detail and the nature of observations to be made are important. Once sound fundamental training is given in educational institutions it would be easy for the employer, whether the Geological Survey, prospecting agency, mining or engineering concern, to obtain suitable men for the particular type of work needed in the organisation. It is not necessary for all the Universities to follow a single type of training for there is a large scope for variations especially in the post-graduate stage where specialised training can be given to the students.

2. Dr. A. G. Jhingran (Geological Survey of India) :

1. Education in Geology should be so broad-based as to embrace besides the various branches of the main subject, courses in fundamentals of mining, ore-dressing, metallurgy, surveying, rock analysis, assaying, etc. Furthermore considerable emphasis should be laid on training in field mapping so that after obtaining the Masters' degree, every candidate should be in a position to undertake field

investigations. It would be advantageous if some training is also imparted in underground mapping.

2. In view of the fact that knowledge of physics and chemistry upto a fairly high standard is required for the study of various branches of geology, and that a certain amount of knowledge of biology and higher mathematics is also helpful in getting such a grasp of the subject as is required of a professional geologist, it is highly desirable that education in Geology should not be commenced before the students have studied other sciences upto Intermediate standard. However, there would be no objection to the introduction of a very elementary course in geology as a part of Natural Sciences or Nature Study at the High School stage.

3. To cover the entire syllabus as suggested in para 1, above, it would be necessary to increase the duration of the existing courses and it is suggested that the syllabus prescribed and the time required for the various degrees in Geology may be so modified as to provide :

(A) A three-year course leading to the B.Sc. Hons. degree, the first two years incorporating a study in three subjects of which Geology should be one and the third year devoted exclusively to the study of Geology, and allied subjects.

and (B) a two-year course, after the above mentioned Hons. Course, leading to the Masters' degrees in which intensive training should be given in one or more branches of Geology and the students be also introduced to methods of research.

To encourage the study of Geology as a cultural subject it would be advantageous to allow the students to qualify for the B.Sc. pass degree after the first two years' study. But the M.Sc. course should be open only to those with an Hons. degree.

4. There should be active co-ordination between the Universities and the Geological Survey of India and other allied Government Departments. With this end in view it is suggested that :

(*a*) a system of reciprocity be introduced under which the experienced officers of the Geological Survey may be attached with the Universities for, say two years at a time, for teaching work and the staff from the universities may join the Survey for a like period.

(*b*) a system of part-time Professorship may be introduced under which the experienced field officers may give courses of lectures on specified subjects during the periods when they are at their respective headquarters. This should be possible at such centres where there are Circle Offices of the Survey and Geology Departments in the respective Universities.

5. It is desirable that each firm or company dealing in minerals, with raisings above a certain specified minimum, which may be determined by a committee appointed by the Government for the purpose, be required by law to engage the services of a qualified geologist and or a mining engineer so that wastage in production is avoided and conservation of useful minerals is fully obtained.

6. For fuller utilisation of the geological personnel in the Geological Survey modern means of mechanical transport in the interior of the country be extended rapidly.

3. DR. A. K. BANERJI (Calcutta) : *Training of a Geologist.*

Students in geology may be broadly classified into three groups :—

(*a*) Those who study the subject only for its intrinsic cultural value and never aspire to be professional geologists. Such students are those who take up the subject in their High School, I.Sc., or B.Sc. (pass) courses.

(*b*) Those who study selected and appropriate parts of the science helpful to a better understanding of their main subjects of study, *e.g.*, civil mining, metallurgy, agriculture and geography.

and (*c*) Those who study geology because they propose to become professional geologists. They may specialise in any one of the following branches of the science :—

(1) Palaeontology, stratigraphy and structural geology.
(2) Petrology and mineralogy.
(3) Mining geology.
(4) Coal geology.
(5) Petroleum geology.
(6) Ore dressing or mineral engineering.
(7) Geophysics.
(8) Engineering geology.
(9) Glass, ceramic, and refractory materials.
(10) Cements and building materials.
(11) Metallic minerals.
(12) Non-metallic minerals of industrial use such as mica, asbestos, abrasives, gemstones, etc.

A special feature of the course in geology for the first group of students should be the elimination of factual details, which merely tend to diminish the cultural value of the science. Such a course should be confined to a consideration of geological agents and processes, palaeogeographical revolutions revealed by stratigraphy, broad stages of landscape evolution, and the description of the most important rock and mineral types with an appreciation of the geological environments of their formation and origin. The second group of students for whom geology is a subsidiary subject, have neither the time nor the necessity for a full course in all the branches of the science and the best way to serve their purpose would be to arrange special condensed courses of lectures to suit their requirements. For the third group of students the present system of teaching B.Sc. (Hon.) and M.Sc. courses over a period of four years should be replaced by a compact course of four years leading to a B.Sc. degree. This course should lead to specialisation in any one of the twelve branches of pure or applied geology mentioned earlier. The first two years of study, when a solid foundation in the fundamentals of geology are to be laid, should be common to all groups of students. The next two years should be devoted to the study of the special subject chosen together with such subsidiary subjects as have a direct bearing to the main subject. Proper importance should be laid on the planning of the syllabuses in subsidiary subjects for different groups of specialists according to their requirements. Surveying and mining should be part of the curriculum. Every University department should be well equipped and staffed to teach as many of the special branches of the science as possible, and conduct research work in them. The teaching course should be followed by research work leading to research degrees for competent students. A student should spend at least three months, during each year of his stay at the university, in the field. During the first two years he should receive practical training in surveying, prospecting and geological mapping. More stress should be laid on mapping in different types of country using different scales of maps than on detailed mapping of a single area. During the last two years applied geology students specialising in minerals should be introduced to the corresponding mineral industries so as to get thoroughly acquainted with the mining, metallurgical and industrial aspects of the subjects of their choice. Similarly appropriate field work should be planned for the other groups of specialists.

In conclusion it has been pointed out that considering present day requirements radical changes and in fact a complete re-organisation of teaching in geology is called for. It has been suggested that contributions to these discussions be carefully reviewed by a committee of experts who should frame concrete recommendations to be transmitted to the proper authorities for actual implementation.

4. Dr. S. C. Chatterji (Patna): *Training of Personnel in Geology.*

The scope of appointment of Geologists in India is very much limited. This is partly due to defective training of the University students on the one hand, and lack of opportunities for employment in the country owing to the backward state of industrialisation. The Geologists turned out by the Universities have little knowledge of prospecting and mining, ore-dressing, etc. and lack confidence in seeking employment with commercial firms. They have, however, one advantage over the students turned out by the technological institutions. Some of them are absorbed in civil posts where a graduate's degree is helpful. This avenue is closed to the students of the School of Mines and similar institutions. We hear the cry that the country needs more and more Geologists but unless there are many more industries, such as ceramic, glass and metal industries, requiring basic mineral raw materials, the geologists trained in Applied Geology have little future prospect of employment. The course of study in the Universities should develop a bias towards the Applied side, concentrating on teaching and training in those branches of mineral industries in which the respective states offer field for exploitation. For example, in Bihar, emphasis should be laid on the study of fuel, metalliferous minerals, clays and limestones and finding out their suitability and better utilisation. The Government of India have taken steps in the right direction in proposing that research activities will be given financial assistance in their Five-year Plan.

The states having mineral deposits should organise their own mineral surveys because the Geological Survey of India cannot be expected to carry out detailed and exhaustive surveys of the mineral wealth of the individual states. The Agricultural Departments should undertake soil surveys not by their untrained staff but by geologists trained in the methods of soil survey, ground water prospecting and conservation

5. Dr. S. N. Wakhaloo (Patna) :

The fact that opportunities of correlation of Indian Formations with the help of fossils are very limited owing to the preponderance of Pre-cambrian crystalline rocks, the author has endeavoured to deal with the overwhelming importance of laying greater stress on Economic Geology than on Palaentology in the curriculum prescribed for the degrees of Bachelor of Science and Master of Science of Indian Universities. The desirability of awarding Bachelor of Science degree with Honours upon completion of third year work and Master of Science degree at the end of the fourth year in all Indian Universities is also stressed. Opportunities must be offered for a certain degree of specialization in the final year with the following alternatives : Metalliferous Deposits, Non-Metalliferous Ore Deposits, Mineralography, Advanced Petrology, Engineering Geology, and Mineral Economics.

In order, however, to meet the needs of some students, the ordinary degree of Bachelor of Science may continue to be awarded after two years study in specific subjects. In the I.Sc. curriculum it is pointed out emphasis may mainly be laid upon the fundamental subjects of Physics, Chemistry, Biology, and Mathematics.

The paper also deals with the avenues open to well trained geologists in the sphere of industrial development of the country particularly in undertaking Scout Prospecting, Hydrographic Surveys, Soil Surveys, Exploratory Surveys, and Organisation of Mineral Selling Industry.

6. Dr. H. N. Das-Gupta (Dhanbad) :

The speaker dealt with the following aspects with regard to training in Metallurgy :

(1) Quality of students passing the Inter Science Examination, with special reference to their capability to take up technical training. (2) Selection of students for metallurgical course, only when the student gives some proof of his aptitude for the subject. This subject should not be imposed on them as is ordinarily the case at present. (3) Training facilities in the institution—these include complete laboratory equipment and workshop accessories. (4) Advisability of exchanging students with the sister institution for laboratory training. (5) Teachers and their qualifications. (6) Research should form a part of the normal duties of a teacher. (7) Provisions for scientific journals and periodicals. (8) The curriculum to be drawn up jointly by the teachers and those occupying key positions in the industry.

7. Dr. J. N. Nanda (New Delhi) :

It must be underlined that subjects like Geology are meant for a professional career and not merely as cultural subjects.

The speaker believes that better work can be done at the University stage if the examination system is improved. In the absence of external examiners and final examinations, the teachers and the taught will work for better standards and can develop individual special subjects. The schools will also thus be able to incorporate local help from industry and Government within their courses.

8. Dr. G. W. Chiplonkar (Saugor) :

Proper utilisation of Geologists is vitally dependent on their competence. Unless they are capable enough to inspire confidence in the mind of the employer, whether industrialist or the Geological Survey of India or any other body, the employers would naturally hesitate to entrust their costly schemes to the available geologists. Unfortunately the training at present being given is fast becoming superficial and a mere class-room work, with an increasing neglect of the field aspect. Grasp of the fundamentals is being lost sight of and there is much of show of the so-called modern and applied aspect. It is not impossible to get an M.Sc. degree without any time doing field work. There is a very undesirable tendency to admitting large number of students with utter disregard to the facilities which the institution could possibly offer.

In matters of teaching it is absolutely necessary to lay stress on strong grounding in the fundamental side and close acquaintance with the methods of field work, prospecting and surveying, training in general principles of mining, ore-dressing and engineering geology should be such as would be enough to make geologists appreciative of the problems of the different lines in which they may be absorbed.

The resources of Colleges and Universities are inevitably limited. Therefore co-operation from industries in the form of finance and apprenticeship facilities would be most desirable. Training camp facilities by the Geological Survey of India should be extended more than what they are at present.

9. Dr. A. S. Kalapesi (Bombay) :

I give below my views with special reference to the following important points :—first, the kind of education and its quality; secondly, the places or institutions where this kind of education is imparted; thirdly, what kind of young men study this subject and with what motives; and lastly, what are the future prospects of those who take geology as a vocation.

If the student learns through well planned methods—which is the real meaning of education, and if these students have proper appreciation of the place of work in life and can find the right kind of work to do, it will release rich potential sources of creative energy.

Most of our colleges offer facilities for undergraduate degree courses. In these institutions more emphasis is laid on the study of pure sciences rather than on the applied side and so the students become familiar with the fundamentals mainly. The teaching of special branches of applied geology is too comprehensive to be embraced in a single college of this kind. Specialization should be avoided at this stage; but should follow after their getting the degree.

It will not be possible for all the existing colleges to do the post-graduate work or to teach special branches of applied geology. This kind of technical and specialised training can only be given in a few selected colleges, having all kinds of facilities, funds and qualified staff.

Of course, in some states a compact group of basic institutions should be established comprising a science college, and a post-graduate institute for research or specialised branches and these colleges should get substantial grant from the government.

The lot of Geologists (Professors) barring a few exceptions is worse in majority of the private colleges—they are ill-paid and no security of the future or pension after retirement. Even today there is a tendency to give education a lower priority. The training that is generally provided today to students is not effective enough to awaken real sparks of interest or release intelligence in any appreciable measure.

10. Mr. Y. Nagappa (Digboi, Assam) :

Training in the field of Stratigraphical Palaeontology has not received sufficient attention in the courses of studies in our universities. As this subject is bound up with the fundamentals of geologic history proper training of the student is necessary so that he understands the forces operating which bring about changes in the sediments and their associated fossils. It was believed that unconformities separating the various subdivisions of geologic time were of a universal nature but recent researches have shown that this is not so. Continuous sediments have often accumulated in places where it is not an easy matter to establish sub-divisions without a proper understanding of characters of these sediments including nature and abundance of fossils, their relation to the bedding, mineral suites, lateral and vertical variation. More attention is therefore quite necessary in imparting proper training in the field and laboratory on the fundamental characters of the strata, changes in facis and environments which will form a foundation for correct understanding of stratigraphic problems.

11. Prof. K. V. Kelkar (Poona) :

Our primary and secondary courses are being radically altered and our university courses will, also, have to be modified, in the near future. Hence we should not, at present, recommend any additions to the courses or any increase in the period of instruction.

Measures like those mentioned below will help to spread geological studies and raise their general standard.

(1) Railway journey at concession fares in the case of teachers and students travelling in the course of their field work or for visiting the Geology Museum at Calcutta or attending a Training Course conducted by the G. S. I. :—The concessions should be available irrespective of their number, and generally during the vacations.

The G. S. I. should arrange to hold short courses, each taking not more than six or five weeks, on subjects like ore-dressing, etc. These should be held in the vacations so that post-graduate students could conveniently attend them. These may also serve as refresher courses to teachers.

12. **Dr. J. N. Basu** (Jadavpur, Calcutta) :

Period of training for engineering graduates should be 4 years after I.Sc. and a year of practical training in vacations and after graduation.

Traditional defects in engineering training in India which is responsible not to turn out Administrator-engineers or Design or Development engineers, can be greatly remedied by introducing post-graduate study and research in engineering and technology. Central Government will do much good to the country and especially to the engineering profession, if its activities are directed towards research and post-graduate study in engineering, rather than towards usual stereotyped graduate training in engineering.

13. **Mr. S. M. Ahmeduddin** (Hyderabad-Deccan) :

Nearly all the eminent geologists of Survey departments always suggest that a student should have the fundamental knowledge of Chemistry, Physics, Mathematics, Surveying, Ore-dressing and Biology, etc., etc., before reading Geology. But I should like to say from my teaching experience that Chemistry helps in Analyses, Mathematics helps in Crystallography and Biology in Palaeontology, but nothing helps when we start lecturing on physical or field Geology or Stratigraphy or Mineralogy or Petrology. We have to teach all the elementary things to a B.Sc. student, sometimes we have to explain what is Geology and its branches. So I suggest that like U.K. and U.S.A. in all the Indian Universities Geology should be taught in Intermediate along with other science subjects, then a student will be able to get some advance knowledge in B.Sc., otherwise it is impossible to give a good knowledge of Geology to B.Sc. students.

14. **Dr. S. P. Chatterjee** (Calcutta) :

Of all the scientific subjects, geography so far has received the least recognition and encouragement in the hands of our educationists and administrators. One of the reasons for this neglect may be the late starting of the teaching of geography at the university level. Until 1929 none of the Indian Universities had departments of geography. And even now, universities like Bombay, Lucknow and Delhi do not provide facilities for training in geography at the highest academic level.

Even where geography is taught at the highest academic level, geography departments are handicapped for want of adequate staff and funds. For example in Calcutta we teach meteorology, pedology and advanced cartography (including photogrammetry) to our post-graduate students, but the laboratory facilities are too inadequate to meet the growing demands. Our laboratories need expansion, and more equipment. The same difficulties are experienced in other centres of geographical studies and research—Aligarh, Banaras, Allahabad, Patna, Madras, Punjab, Nagpur and Poona.

Most of the students passing out of our geography departments do not get jobs in their lines of specialisation. I fail to understand why students taking M.Sc. degrees with cartography as a special subject would not be given preference to ordinary Mathematics graduates by Survey of India at the time of recruiting their staff. Similarly, the Meteorology Department ought to give preference to M.Sc.'s in geography with meteorology as a special subject. The Agricultural Departments should also welcome our students specialising in pedology for soil survey work and land use survey. Two of our students are working with the D.V.C. and the Agricultural Department of the Government of West Bengal in connection with the conservation and utilisation of soil schemes and I am glad to say that their work is being appreciated by the proper authorities. This is just the beginning and much remains to be done.

Until geography is established as a professional field in Government, there cannot be proper utilisation of our trained personnel. We must have a Geographical Branch attached to existing Government departments. In Canada, for example, the Geographical Branch, attached to the Department of Mines and Surveys, is the largest single employer of geographers in the country. In the United States many of the Government departments and some of the independent Government agencies maintain staffs of research geographers to carry on regional investigations or to advise the Government officials regarding geographic interpretations of problems in national and international affairs. I may point out that the Government departments most active in geographic research in the United

States are those of (1) State, (2) the Interior, (3) Commerce, (4) Defence and (5) Agriculture. If the corresponding Government departments in India maintain a staff of geographers, the students passing out of geography departments will be able to utilise their geographical knowledge and will not have to take to the only profession, I mean, Teaching, which is open to them at the moment. We will then be able to attract the better types of students, who in their turn, would justify the money spent for giving them adequate training.

15. **Dr. G. S. Puri** (Dehra-Dun) :

Much has been said by previous speakers for increasing from four to five years the course in geology, but without advocating for any increase in the time to be put on a degree course I wish to mention the debt of gratitude that forestry owes to geology and have a hope that geologists will in future look a little more into the wants of the students of vegetation. It is now becoming increasingly evident that forest vegetation is intimately related to geology. For example, I may mention that in the Himalayas the quartzite formation invariably bears *Pinus longifolia* community and *Abies webbiana* occupies large sketches of glacial moraines. Schists support on scarp slope the *Pinus excelsa* community, and on the dip slope the vegetation is predominantly composed of *Cedrus deodara* community. The limit of the Siwaliks in the North-West India is the limit of the *Shorea robusta* community. In the Peninsular India, *Tectona grandis* occupies all basic rocks and along the Satpuras it has been possible to superimpose the distribution map of teak with the distribution map of trap rocks.

While the relationship of geology to vegetation is so well established, it is the non-geologist who has mostly brought forth this relationship. If in the course of geologist's training, a short course on vegetation is included it could enable the geologist to help himself in finding new avenues of employment for his class. In the Forest Department, students with a geology degree are already finding honoured place and some acquaintance with broad basis of India's vegetation will greatly make geological literature more useful to botanists and foresters.

XV. SOVIET GENETICS.

(*Section of Botany, jointly with Sections of Agricultural Sciences and Zoology & Entomology.*)

Chairman : **Dr. R. K. Saksena** (Allahabad).

1. **Dr. P. Maheshwari** (Delhi) :

Science is international and there cannot really be any such thing as Soviet Genetics apart from other genetics. However, since the Russian school itself insists on calling it by that name, it is convenient to adopt the term. The differences between Soviet Genetics and International Genetics are set out in the following table :

Soviet Genetics	International Genetics
1. Heredity is the capacity of the living body to demand definite conditions for its life and development and to react in a definite way to any given conditions. Existence of genes is denied.	1. Heredity is the property by virtue of which offspring inherit the nature and characteristics of parents and ancestors. The gene is considered the atom of heredity.
2. The hereditary nature of any organism can be changed by environment. Thus spring wheat may be changed into autumn wheat in 2-3 years, tetraploid wheat into hexaploid, and the last into rye, barley and oat which are diploid.	2. Environment certainly influences the organism upon which it acts but the genes usually remain unaffected. Transmutations of cereals reported from Russia are regarded with great scepticism and considered impossible on the basis of environmental influences alone.
3. In free pollination the ovum selects the best pollen. This has been referred to by Lysenko and Prezent as "marriage for love."	3. No such selectivity can be attributed to the ovum, although pollen tubes from different varieties may grow in the style at different rates.

SOVIET GENETICS	INTERNATIONAL GENETICS
4. Those characters which are best adapted to the local environment are the dominant ones.	4. Dominance relations do not follow any such rule.
5. Grafting may result in "vegetative" hybridization, although the only material connection between the stock and scion is the cell-sap.	5. The mutual effect of stock and scion is admitted but the progeny remains unaffected.
6. It is possible to have triparental hybrids, although the gametes of only two may actually unite.	6. This is considered highly improbable.
7. There is no competition between individuals of the same species.	7. Both inter- and intraspecific competitions are believed to exist.

The most important publication which gives an insight into the trends in Soviet genetics is the verbatim report entitled "Situation in Biological Science" published in English by the Foreign Languages Publishing House, Moscow. The concluding part of it is distressing to read for it leaves no doubt that bona fide scientists had to make confessions and retract from the original position they had taken up for fear of persecution by party bosses.

The formation of "vegetative" hybrids between the stock and the scion is given great importance by Russians as disproving the chromosome theory of heredity. But Wilson and Withmer (1946), Sax (1951), Brix (1952) and Rick (1952) have repeated these experiments in England, America and Western Germany and found that while there is a mutual effect between the stock and the scion, this is not passed on to the progeny. Russian investigators do not believe in pure lines, nor in the necessity of bagging after pollination. Therefore their observations and conclusions cannot be accepted unreservedly.

In nature we have various phanerogamic parasites like *Orobanche, Aeginetia* and *Loranthus* which grow upon the host right from a very early stage. No hybridization occurs, however, between the host and the parasite.

Experiments on *Acetabularia* performed in 1943 by the German botanist Hämmerling are quite conclusive on this point. He took two species *A. crenulata* (A) and *A. mediterranea* (B). When the stem of A was grafted on to the nucleated base of B, the regenerated umbrella-shaped top was not like that of A but like that of B. Reciprocal grafts also gave the expected result, thereby proving the predominant role of the nucleus.

If experiments are repeated in India on Lysenko's lines, proper precautions have to be observed and the basal part of the plant which has supplied the scion should be retained as a control.

Concerning the appearance of grains of rye, oat and barley in the spikes of wheat, it is not possible to explain such a phenomenon except on the hypothesis that the new embryo arose from the male gamete of a pollen tube of rye, oat or barley respectively (androgenesis). Bread wheats are hexaploid ($2n=42$) and rye is a diploid ($2n=12$). So any transmutation of one into the other as the direct result of environment is impossible. Not only is the number of chromosomes different but there are qualitative differences which cause these plants to be placed in different genera.

The change postulated by Lysenko is of a higher order than even that of cat and dog and in the present state of our knowledge such things would only be considered superstitions.

Replying to certain questions at the end of the symposium it was pointed out that the theory of polygenic inheritance was not to be accredited to Lysenko for he did not believe in genes at all. Nor did the concept of cytoplasmic inheritance originate with Lysenko for such inheritance was discovered as early as 1909 by Correns, and Wilson (1928) has a significant paragraph to this effect in his well known book entitled "Cell in Development and Heredity".

2. DR. O. J. EIGSTI :

Genetics, like any other science, depends upon the scientific method for the establishment of facts; valuable theoretically and/or practically. Only by strict adherence to correct methods can we expect to develop knowledge that has significance for immediate use or application at some future date. Our discussion today is important because we are hereby given an opportunity to reaffirm the conviction that the methods of science, rather than doctrines, are of vital importance in developing the science of Genetics.

An example of scientific discovery by correct method is Mendel's establishment of the facts regarding variation and heredity in plants. His methods were so clearly written and data were reported in such detail that long after his death an exact repetition was possible that confirmed his original conclusions. We are told about new and interesting experiments from Lysenkos Soviet Biology, Moscow, 1948. But one authority with fifty years of personal research in the field of genetics and plants, Professor M. B. Crane of England, after reviewing the work, concluded that "Lysenko and his associates seem to have no scientific method." Every one realizes that many details, necessary for evaluating results or, repeating experiments done in U.S.S.R., are omitted. From a scientific point of view such lack in detail and method are unfortunate for scientists in other parts of the world. But a practical plant breeder is often not concerned with the scientific method and is interested only in the practical results. These have local value and are of no significance internationally.

Soviet Biologists report on the conversion of "28 chromosome wheat" to "42 chromosome wheat" by changing the planting date from spring to autumn. In light of our knowledge about converting tetraploid species into hexaploids these reports are of interest but we have no way to evaluate the method or repeat the experiment. Up to 1948 we know that considerable polyploidy breeding was underway in U.S.S.R. Our information since then has been very meager.

Today research with colchicine in Russia is not considered "appropriate" or "correct" but no comparative studies are reported that demonstrate the difference between doubling chromosomes by colchicine or some other method.

The issue is one of scientific method as applied to the discovery of genetic laws vs. a practical plant breeding approach interested in practical results only. The repetition of practical tests is not possible. But the "saddest feature" in the present controversy is that in Russia, "intimidation, imprisonment and exile" has been the procedure to establish a doctrine. By these methods the science of genetics has in recent years been destroyed in the Soviet Union. "Soviet Genetics" has only practical objectives and evaluation of research from a scientific point of view is not possible.

3. Dr. G. S. Puri (Dehra-Dun):

While a good deal has been said by various speakers—both for and against the Soviet genetics, unfortunately little data have been brought forth by both groups of speakers to enable any one to come to any definite conclusions. While accepting the gene theory, one cannot totally ignore the impact of environment on the growth and development of organisms. As an Ecologist I can say that environment has a good deal to do with plants.

There is another aspect which needs a careful consideration and that is that while a good deal of studies have been done on genetics, relatively little has been done on the study of environment. Environment is a complex of factors, which are variable and they certainly produce new races of plants and animals. I am inclined to agree fully with Dr. Hora that environment is a very potent factor and a detailed study should be made to evaluate the interactions of the various factors of the environment on the plant growth, so that we may be able to appreciate the significance of Soviet discoveries in genetics.

XVI. FOSSIL PLANTS AS CRITERIA OF THE PALAEO-ECOLOGICAL CONDITIONS.

(*Section of Botany, jointly with Section of Geology and Geography.*)
Chairman: Dr. R. K. Saksena (Allahabad).

1. Prof. G. A. Hoeg opened the discussion.
2. Dr. Erling Dorf (Princeton, N. J., U.S.A.):

The study of plant remains in the ash deposits of Parécutin Volcano, Mexico, has indicated that the kinds, quantity, and quality of the buried plant remains depends largely on four factors: (1) the habits of the living plants in the shedding of leaves, needles, or cones, (2) the qualities of the plant materials in resisting abrasion or destruction before burial, (3) the proximity of the buried plant remains to their living parent trees or shrubs, and (4) the processes involved in the transportation and burial of the plant materials.

It was emphasized that paleobotanists studying fossil plants of ancient volcanic deposits must fully appreciate not only the ecology and habits of the living plants, but also the geologic conditions resulting in the deposition of the various sedimentary facies involved.

3. Dr. K. Ahmad Chowdhury (Dehra-Dun) :

I wish to confine my remarks on the flowering plants as creteria of the Paleo-climatic conditions. I do not think I am in a position to talk on Paleo-ecological conditions of the past. The modern ecology requires much more detailed information than what we have in our possession on the past vegetation, and hence my objection.

Researches on the Cretaceous fossil flora of Europe indicate that the climate was tropical during the period. The Eocene, Oligocene and Miocene flora of Western Europe was "an admixture of elements now living in temperate Europe with others which are tropical or sub-tropical in range." It is also known that the early Tertiary flora of North America was much richer than the present flora in existence there. During the middle Tertiary period, only temperate plants were growing in Eastern North Asia and Eastern North America. However in, West North America there is an indication of subtropical plants in existence during middle and upper Miocene period.

On the other hand, the Tertiary flora of Indo-Malayan-region shows only a tropical range, although there is some evidence of their migration within the region. Here I wish to point out that the data available on the Cretaceous and Tertiary flora of the Indo-Malayan region is very scanty. All these conclusions on climate are drawn on the belief that there had been little change in the general behaviour of the plants to their environments during the last 100 million years. This point requires looking into in the light of the present trend of dynamic evolution.

Paleobotanist can seldom obtain all the parts of a plant that are used by the systematic botanists for its identification. Flowers are rarely found. Leaves, twigs, fruits, seeds and pollen grains form the greater portion of the paleobotanist's material for identification. In view of this, I wish to bring to your notice the latest work on the different parts of plants, for the consideration of the paleobotanists gathered here. Ashby's work on the leaf variation of *Ipomoea purpurea* and *Ipomoea caerulea* is extremely interesting. He found not only a difference in the size of the leaves of these plants but also in their shape and texture. Twigs containing secondary xylem have been worked out in great detail in many laboratories which work on wood anatomy of perennial plants. These workers have shown that differentiation of secondary xylem is not always possible at species level. Genera are, however, well defined. At family level, anatomical structure of secondary xylem is usually distinct. Now Salisbury's work on fruits and seeds of *Atriplex hortensis*, is very illuminating. He has reported two kinds of seeds in this plant—one large and brown, and the other small and black. They are entirely different to look at, and it is difficult to credit their generic, let alone their specific identity. Study on pollen grains, by Cookson and others, have indicated difference in the shape and size of the grain of the same genus, *e.g.*, *Dacrydium* and *Banksia*. All these researches bring out the fact that the Paleobotanists have to be very careful with the material of flowering plants that they are handling. It is not my intention to say that the work on the isolated parts of the flowering plant should not be continued. All I wish to point out is this that paleobotanists have to be extremely careful and must examine many samples before they come to a definite conclusion.

Finally, I would refer to an important observation that has been made by Bailey. Much of the confusion that exists at present in the understanding of the classification and phylogeny of Angiosperms will be removed, if we get used to the fact that all the parts and the tissues of an organism do not show a synchronized evolution. Intensive work is all that is necessary by the paleobotanists for many years from now, and the time will come soon when a comparative study of the different parts will be successfully made and the existence of the plants in geological times be made beyond doubt. It is then only that we can talk of Paleo-climatic and Paleo-ecological conditions.

4. Dr. G. S. Puri (Dehra-Dun) :

The concept that fossil plants indicate paleo-ecological conditions is based on the simple principle of plant indicators. Paleo-botanists have been able to prepare reconstructions of fossil floras and the environment in which they had lived. The correctness of these reconstructions cannot be verified in so far as the

Paleozoic and Mesozoic periods go. But some of the reconstructions made for the Tertiary and even Cretaceous periods, in which remains of modern angiospermic plants have been found, were severely criticised resulting in bringing into disrepute much of the early paleo-botanical work.

Unfortunately, paleo-botanists of the last century and even of the early part of the present century did not realise the importance of the twin principle of plant succession along with plant indicators. The former principle deals with dynamic changes or succession that vegetation shows under one and the same climate, at the same place.

For example, a river alluvium in North India may be successively occupied by the pioneer *Dalbergia sissoo—Acacia catechu* community, early seral *Trewia nudiflora—Holoptelea integerifolia* community and a late seral *Holoptelea-Eugenia jambolana—Bombax malabaricum* community.

In the North-Western Himalayas at altitudes of 5000 ft. or above, river alluvium may bear a pioneer community of *Ulmus wallichiana—Alnus nitida—Populus ciliata* and seral community of blue pine—*Cedrus deodara* and a stable community of pure *Cedrus deodara*. These successional stages indicate a definite succession of edaphic and micro-environmental conditions. Unless a paleobotanist analysing the fossil remains of such communities is fully aware of these ecological changes he may not be able to sketch clearly the changes in the past environment.

Another point is about the geographical distribution of species. *Shorea robusta* along with *Terminalia tomentosa, Adina cordifolia*, *Anogeissus latifolia* has a very wide geographical distribution, occurring in regions of different climatic, geological and pedologic features. But the floristic composition of the community in which these plants occur, the size and growth of the trees give indication of the true nature of the environmental conditions in which they live.

While an Ecologist has the advantages of all this knowledge, a paleo-ecologist has a very limited material, which may be only a few pieces of leaves, fruits or flowers, to work with. It is very difficult to say much about the paleo-ecological conditions in which the plant lived in the past on only a limited material. Paleobotanist must always keep in mind that one swallow cannot make Summer and one thistle does not indicate a desert. But when swallows come to stay and thistles occur in abundance we can use these as indicators for particular purposes.

A very great caution is, therefore, necessary in theorising on paleo-ecological conditions, especially, when the fossil material available is small and fragmentary.

In the identification of fossil floras ecological method must always be used along with morphological and anatomical characters of the fossils. Plants occur in definite plant communities and if a paleobotanist, unmindful of this principle, brings into a community an unusual associate, it becomes extremely difficult to give any clear interpretation of paleo-ecological conditions.

Leaves are reputed to be variable in these morphological features but a closer study reveals that similar variations occur, equally prominently in flowers, fruits, seeds, pollen grains and even in anatomical features. But all these variations, at least in the case of leaves, are regular and when a due care is taken identification of fossil leaves by comparison with living leaves can be attained very accurately, especially when ecological principles are used.

XVII. COMMUNITY PROJECTS.

(Section of Agricultural Sciences jointly with Sections of Medical and Veterinary Sciences, Psychology and Statistics.)

Chairman : Dr. N. Parthasarathy, New Delhi.

1. Dr. Parthasarathy, in his introductory remarks, pointed out that the most welcome feature of the 'Community Project' programme is that it aims at development of village Community in every aspect like agriculture, sanitation, education and in the encouragement of leadership in villages. The President emphasised that a psychological approach to the problem is vital when dealing with villagers as the idea behind the project is not so much the mere provision of financial aid in schemes of village uplift but to make the villagers themselves more self-reliant. They will be trained to take the initiative in local betterment programmes and thereby raise the standard of living. He concluded by saying that he anticipated a rapid improvement in the condition of villages in the near future through the successful operation of the 'Community Project'.

2. Dr. Delton C. Beier, Lucknow.

Community planners too often ignore the fact that the basic unit in the community plan is the citizen. Planning from the top too often involves the biases and the projections of the leaders. The research of psychologists and others have indicated that we not only react in terms of the current stimulus situation but also we react as a product of our reactional biographies, or history. Individuals who make up communities have needs, the more related and relevant to these needs community projects are the more apt they are to be successful. He must also realize that, as individuals are sometimes unaware of their needs, so too a community may be. There are psychological, sociological, etc., techniques of determining the needs and attitudes of individuals and groups. Utilization of these techniques will serve the leaders and government to prevent too great discrepancies existing between the goals of the community project and the immediate and long term goals of the people they are meant to aid. Projects which are either too advanced or lag behind the needs of the people are both wasteful and irrelevant and though they may meet with passive acceptance, they require active participation and support to succeed. Sensitivity to the basic and acquired needs of people, therefore, is a primary requirement of community project planners and the techniques for determining these needs have been developed by the social scientists.

3. Sri M. U. S. Jung, Lucknow.

In the words of the Prime Minister of India "Happiness and work" are wedded together, for there can be no true happiness without feeling of doing some thing worthwhile. To realise this we have to pursue peaceful methods in a democratic way.

Today. in free India the villager must through education and leadership be motivated to want for himself and his family more than survival.

Community projects have been started with a view to secure the fullest development of the material and human resources of the area for the benefit of the community.

I will speak on a few specific points concerning the Community Projects launched by the Central and State Governments.

Loans (Revenue Department, Reserve Bank and private sectors).

In the absence of any organisation or machinery to dessiminate the available information to the agriculturist in an intelligible or acceptable form, it is difficult for people to cooperate with Government agencies.

In these Development Projects we have got a Government sector and a private sector. Both of them to have a coordinated effort to see the plan going.

Our greatest set-back in the present working is that loans allotted for development work are not available promptly and there is something in the present set up of working these projects that the help reaches the destination when it is almost too late to utilise it.

I recommend that a strong committee be appointed by the Central and State Governments to see that funds allotted by Government are promptly available as well as see that private sector comes forward to invest capital.

The development of textile and sugarcane industries is an example and it is due to private enterprise that these industries have gone ahead in India.

Agricultural Development should be our primary objective in which lies our salvation and the students in our schools and colleges should not be isolated from the villages in their thought, outlook and manner of living. Because the Indian cultivator may be unlettered, behind him lies the experience of centuries, a practical knowledge of agriculture may be primitive which is far more valuable than theory.

Utilisation of Village Technical Personnel.

The modern agricultural Engineers should concentrate their attention on the importance of existing indigenous implements. The problems and difficulties which the cultivators come across in their daily work should be systematically studied and tackled.

Dr. Punjabrao Deshmukh has often said that not in the distant future each state should add at least one Agricultural Engineer to their existing staff entirely for research and improvement of agricultural implements. We have been stressing too much on improved varieties of seeds, manures, pests and diseases but most of the agricultural scientists in our research stations are hardly acquainted with common implements and their working.

The first step to be taken is to have a complete survey made to get more exact factual information than is available about the implements actually used, their sources, life, cost and efficiency in work.

LAND : For the progress of agriculture an effective and comprehensive policy is essential. We have gone ahead to some extent by abolishing zamindari system in some states of the country. The next step will be to develop a collective and enthusiastic will in our cultivators to work together and drop the parts of their individuality which separates them from the main spring of life. The cooperative and collective farming with latest techniques of agriculture will expedite our approach to the solution.

At present there is some hitch in the mind of the farmers and cultivators due to restriction in land allotment to individuals in various states and the general agricultural development has a set-back in this transitional period, as people are reluctant to invest their capital in land development activities fearing that the land may be taken away with small compensation.

There is one thing which needs careful attention and consideration that Agriculture-Horticulture-Animal Husbandry should be given top priority amongst the programmes of development. No nation of the world can prove or has proved that being in extreme food shortage they have taken recourse other than increasing food production. A General has said "Army marches on its stomach", without food, therefore, there is no health and no mind and no heart. It is therefore very essential that Agriculture should be the first problem to be taken from the start. Today's America is not the outcome of all kinds of developments at one time but the development of Agriculture and Production in the beginning to be followed by the improvements on education and communication, etc., etc.

4. DR. G. V. CHALAM :

The Community project aims at developing leadership among the villagers so that they can inspire confidence among the villagers to adopt the various improved methods either in Agriculture, Sanitation, Education and Animal Husbandry.

I can speak about the general outline of the Community projects in Orissa which are more or less on the same pattern as anywhere in India. From the organisation point of view there is a Development Commissioner who is the sole administrator of the projects. The Executive head is the Director of Community Projects. Under him in every project there is a project officer. The Project Officer is assisted by Specialists in Agriculture, Veterinary, Co-operation, Public Health and Education. There are several village level workers in each project depending upon the number of villages in that project. The village level workers receive a comprehensive training of 3 months in all the above subjects. In Orissa there are three Community projects in the districts of Kalahandi, Ganjam and Balasore. Besides these three projects there are two similar projects undertaken by two other organisations such as the Ford Foundation and the American Friends Service Society. The Ford Foundation Project works in Cuttack District and the American Friends Service Society works in Sambalpur District. As a matter of fact the selection of these areas is based upon the scope and possibility of adopting improved methods of Agriculture. Prior to the launching of the Community project they were under the Intensive Cultivation Schemes where the cultivators are in a receptive mood for any improved method.

The first period of the programme of Community projects covers a period of 3 years divided on the following basis.

1. Conception stage 3 months.
2. Initiation stage 6 months.
3. Operation stage 18 months.
4. Consolidation stage 6 months.
5. Finalisation stage 3 months.

For the present they have just completed the conception stage. The conception stage covers mostly the collection of data regarding the composition of the population and their occupation and the analysis of the human material available for the development work.

At this stage I must say that in the project that is being worked by the American Friends Service Society, they have attached an anthropological adviser for the collection of available data on the social composition of the people. I find such a data gives very valuable information which takes us to the second stage of initiation where proper lines of work can be inaugurated. For example I may give a particular set of data that is collected in the project at Bhadrak in Balasore District. This project covers 172 villages and the area is over 200 sq. miles with a population of 34,382. The area under cultivation is 34,000 acres.

Now how this population of 34,382 residing in 200 villages is served by different public offices or artisans who are indispensable for the village communities may be seen by the figures given below.

1.	Post Offices	4
2.	Roads	29½ miles
3.	Dispensaries	2
4.	Schools	28
5.	Bullock Carts	77
6.	Village Oil Mills	70
7.	Potters	67
8.	Blacksmiths	84
9.	Carpenters	95
10.	Power Rice Hullers	10
11.	Cycle Repairer	1
12.	Basket Makers	127

I have already stated earlier that the primary object in working up in the project is to develop leadership among the villagers. How this is done?

For example in this area about 30 irrigation projects have been constructed with an ayacut area of 3,400 acres which is 1/10th of the total area under cultivation. In the construction of minor Irrigation Projects it has been decided that 50% of the cost must be borne by the villagers. The Government in this project have made slight alteration that the Government will supply only all the materials and the technical advice required for the construction of the project. The man power will be supplied on a voluntary basis by villagers themselves. Such a situation only brings up some leadership among the villagers who can consolidate the workers and bring them up to work for the general welfare of the village community.

Further on the basis of the data collected in the conception stage the lines work according to the needs of the village will be initiated in the second stage which has just begun.

5. **Dr. Narendra Kumar Roy** (Calcutta) :

The whole project has as its ultimate aim—the solution of our economic and health problems. The success depends on the training of the village mind, so that they may realize the real object. Time has long past when anything taken-up could be left haphazard. It is essential therefore that the people amongst whom the project is to be worked out are made receptive by practical applications of scientific achievements. What our country at present requires badly is application of what we know and endeavour to improve upon them. When the people will realize this fully then and then alone we may hope this Community project to be effective.

XVIII. THE PROBLEM OF FOOD DEFICIT IN INDIA.

(Section of Physiology jointly with Medical and Veterinary Sciences, Zoology & Entomology, Chemistry, Geology & Geography and Agricultural Sciences).

Chairman : **Dr. N. D. Kehar**, Izatnagar.

Inaugurating the symposium, Dr. Kehar remarked that "it must be conceded that next to air and water, food is the chief item for the preservation of life both in man and animal. It seems, however, paradoxical that although one-sixth of the world population is located in India out of which almost 80% are engaged in agriculture and food production, neither men get two square meals a day, nor are the animals well fed."

Dr. Kehar added that "in designing the food policy of a nation, three things must be taken into consideration (1) adequate supply of calories, (2) liberal supply of protective foods and (3) a reasonable range of variety of the diet".

He pointed out that in terms of optimum nutrition of a people, the most adequate diet is the one that contains liberal amounts of animal products. According to a recent estimate, the position with regard to the availability of food stuffs for human consumption is as follows :—

Food requirement of human beings.

	Cereal	Milk	Fish or meat	Eggs
	In million tons			
Available	41	18	0·8	2,790
Required	43	30	9·0	110 thousand million

From the above figures it is obvious that the shortage of animal products is of a great magnitude as compared to cereals. This, therefore, brings into prominence the justification for developing sound animal industry, though its extent may be governed by economic considerations. The livestock and especially the cattle play a special role not only in concentrating the plant and plant products into more assimilable, nutritious and palatable forms of human diet, but also in contributing towards soil fertility. Thus they prove to be an economic assets, in the efficiency complex of human food production.

Recently researches have shown that liberal provision of adequate food to the animal is a prime requisite for efficient production of animal products of high nutritive value as well as palatability, for human consumption. The character of the soil plays an important role in determining the nutritive value of the plants on which depends the nutrition of animals. Thus animal and human nutrition ties back into agriculture and to the soil.

In India, the majority of the population depend on a diet of vegetable origin. It has been found that malignant malnutrition is fairly common amongst the peoples living on plant foods. Milk is, however, the best supplement to diets of plant origin.

Milk production has been said to be the back bone of agriculture and milk consumption the key stone of human nutrition but, unfortunately, it is very rare and most expensive in India, as compared to other countries in the world. The average animal protein consumption in India is 5·8 gms. as against the normal requirement of 33 gms. per head per day.

The livestock in India are poor producers of milk and meat. One of the chief reasons of their degenerated condition is semi-starvation. It has been estimated that the food requirement of the livestock is short by 77% in digestible crude protein and 62% in starch equivalent.

It must be remembered that in our agricultural economy, cattle and human beings constitute a relation of interdependence and not of competition. The cattle convert most efficiently the coarse fodders, that are inedible for human consumption and non-protein nitrogen compounds and inferior proteins into the best animal protein of milk and meat for human consumption; and thus occupy a unique position in human food production.

In order to step up the production of human food and supply optimum nutrition to the millions of our people it is necessary to increase the productive potentialities of Indian live-stock through proper feeding, breeding and disease control and also by protecting the soil from erosion by wind and precipitation.

Since the problem of providing adequate food has been attracting the attention of a large number of scientific workers in diverse fields, this symposium in which Presidents of the Section of Physiology, Agricultural Sciences, Botany, Zoology and Entomology, Medical and Veterinary Sciences and Chemistry have kindly consented to cooperate provides a unique opportunity for pooling ideas for the formulation of a sound policy for the future.

1. Mr. Norris E. Dodd, Director General, F.A.O.*

In undertaking to participate in a discussion of the problem of India's food deficit, I am keenly aware of the difficult position in which I place myself; this problem is one on which there is so much to do, and about which so much has been said, that almost any contribution must run a risk of belabouring the obvious and of restating the familiar. Yet there must be something new to be said relating to something new to be done, which will in time bring about at least a partial solution to the problem. This discussion might lead to some useful development; I have therefore thought it best to undertake a brief systematic review and to make some observations which may be pertinent to the general situation.

Three major aspects might receive attention: first, the historical aspect, its manifestation at various points in history and its causes and effects at various times; second, the contemporary aspect, the nature of the present deficit and its effects upon Indian economy and society; third, the elimination of the deficit. The first is possibly of least importance and, to me, the second is somewhat less important than the third; I, therefore, propose to give most attention to the ways and means which exist, or might be expected to come into existence, for eliminating the food deficit in this great country.

The Nature of Food Deficits

It is not enough to say "there is insufficient food in India, let us produce more". In order to develop any action to eliminate famine, it is necessary to know what kinds and quantities of food are required, and where these are required. A situation which contains a constant risk of famine does not permit complacency : it demands the best planned disposition of forces to win and distribute the necessary foodstuffs. Nor is it possible to leave these matters to adjust themselves at a level of individual wisdom and good sense : Government must intervene, and in order to do so it must arm itself with the necessary information.

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* This note was read by Dr. R. S. Whyte.

A deficit may be, by definition, no more than the difference between what is required and what is available, but such a definition is most inadequate. Requirement is extremely variable, and there are numerous kinds and degrees of availability. Requirement ranges between that which permits bare existence (and staves off starvation) and that on which economic efficiency and social competence may be built; these limits vary for the individual according to age, habits and activity. The situation is greatly complicated by differences in taste and in attitude towards requirement. There is the complication of the dietary pattern, or the form in which the foodstuffs are taken—a sufficiency of one kind of food for one person might be virtual starvation for another.

There is, of course, the common meeting ground of calories; it is possible to decide, upon the advice of nutritionists, economists and others, the general level of supplies which ought to be available for different categories of people, such as for children, those engaged in light or heavy labour, and so forth. General estimates have been made that the total food supplies should furnish 2,250 calories per head per day. Such an average calorie intake would ensure, it is thought, absence of starvation, and would give adequate energy for efficient work by the active sector of the population. This level was not reached before the Second World War, the average intake then being about 1,700 calories, or 80% of the desirable level; in the post-war years the intake fell to 72% (of the estimated need) in 1948/49 and 1949-50, and 70% in 1950-51. FAO's Second World Food survey suggests that an intake of 2,000 calories per head per day might be achievable by 1960 : that is, 89% of the estimated need.

Even this simple indicator method shows that the problem is serious, but the matter is manifestly much more complicated. People vary in respect of the form in which they wish to take their food, especially in India, where there is first the difference between vegetarians and non-vegetarians, and within each of these major groups a wide range of food preferences. Although these preferences are undergoing substantial modification, it will not be possible at any time to overlook them. The pattern of diets in India is extremely complex; although difficult to compile, a table showing the numbers of people of each dietary pattern in each of your States might be an indispensable basis to effective analysis of needs. It would then be necessary to express these requirements in terms of the proximate constituents, the carbohydrates, fats and proteins, of the different dietary elements, and to consider the data in terms of energy-supplying and protective foods respectively.

The energy supplied by cereals starchy roots, sugars and fats in the Indian diet was 1,270 calories in 1948-49, 1,320 in 1949-50 and 1,260 in 1950-51 : an average of 80% of the calorie intake. If these foods were to be expected to supply this proportion of the calories at the desired level of 2,250, the deficit in these categories has been about 30% during the past few years; to achieve the indicated target for 1960 the production of these foods must increase by 35% in the case of cereals, 41% for starchy roots, 14% for sugar and 61% for fats. The protective foods naturally show similar deficits.

It is necessary to consider two other aspects which we may call the physical and the economic. A deficit should be regarded as a situation which, affecting individuals, families and communities, is not eliminated by arithmetical operations. Surpluses are only potential availabilities which may be used to improve situations where deficits occur. As long as stored food continues to be surplus, people continue to starve in deficit areas; the food deficit of any country is not the difference between the total supplies available and the total needs, but the accumulated total of the many individual differences between requirements and availability, at least of each State, if not of each district and even of each village. The treatment of situations where deficits in certain localities may be relieved by surpluses elsewhere, is not merely a matter of transport, but involves at least some administrative action; there is also the economic aspect, and this leads us to the third aspect of food deficits. For the individual other than the farmer, availability means that which he can take and eat (or give to his family), and what he can take depends upon the money which he has in his pocket, and on the price of food. If he has no money no food is available to him, no matter how large the stocks in the godowns, unless the community should allow him free supplies. One could cite many instances where physical availabilities have exceeded requirements, while the situation of the consumers was such that serious deficits existed.

A simple national calculation in which a theoretical requirement per head is compared with the dietary equivalent of the total supplies available will only partially reveal the gravity of the situation. The actual deficit will inevitably be greater than the calculated deficit because of the operation of a series of factors; first, those which lead to the production in any locality of supplies unsuitable to the inhabitants of that locality; second, the physical and economic factors which impede movement of supplies and serve to maintain surpluses; third, the economic factors which affect the purchasing power of the consumer, placing physically available supplies beyond his economic reach.

There are two principal ways in which food deficits may be eliminated, namely, the increase and improvement of supplies, and the physical and economic mobilization of supplies.

One last word on the nature of deficits. I have mentioned the changes in dietary pattern which are taking place and are constantly causing a change in the requirement, but I have not mentioned the quantitative change which is always taking place, in an upward sense, in the total requirement. To many people this upward trend in population means an ever-widening gap between food requirement and food supply.

It is clear that the current food deficit of India is not a temporary dislocation, accountable to postwar abnormality or persistently adverse weather conditions, but is a manifestation of a long-term and growing disequilibrium between agricultural production and population. The population has doubled within the last 50 years without a significant increase in area under cultivation or extension of irrigation. Within the past 10 years, the average annual production of food grains has remained static—at about 43 and a half million tons—while population rose 13%, from 322 to over 364 million. With four million additional people to feed every year, and the yields of principal crops remaining stationary or even declining, there has been an ever-increasing dependence on imported food grains. Your Government has, however, set self-sufficiency as its ultimate ideal, and great progress toward this objective may be expected.

Eliminating the Deficit

The analysis of needs will furnish a basis for a government plan of action. It is generally conceded that Government must intervene in such probelms of national importance; the publications of your Government indicate that it accepts the responsibility to provide overall direction to the community in this matter. It is apparent that your Government has a four-point approach to this problem, which may be expressed as follows :—

Increase in supplies;
Improvement in supplies;
Protection of supplies;
Control of supplies.

In referring to an increase in supplies, I mean an increase in the total supplies in the country. For a particular village or community, just as for the nation as a whole, supplies may be increased by increasing local production *and* by bringing supplies from beyond the limits of the community. Now although this must be done on a national basis, we must be careful to avoid allowing the accountancy in connection with the movement of supplies to confuse the basic situation; a more important aspect is that, just as the national deficit is a total of community deficits, so also is it true that the total production of the country is the total of a vast number of individual contributions from a great many farmers and fishermen; increase in individual production means reduced individual deficit which thus means reduced national deficit.

Increase in supplies

The national total supplies can be increased by increase in local production and by increase in importation. The increase in local production is the most important element at the moment, and should receive the greatest attention.

It is possible to consider increase in local production under five headings :—

(*i*) Extension of production operations to make use of resources.
(*ii*) Planning of operations to ensure best use of resources.
(*iii*) Discovery of improved technological methods for the exploitation of resources.
(*iv*) Discovery and utilization of methods of improving the resources.
(*v*) Improvement of the manpower contribution to the production process.

It may be difficult to believe that there could yet remain natural resources which were not being exploited; yet certain States of India have legislation on their Statute books empowering Government to take possession of neglected land and to bring it into useful exploitation.

Your country makes little use of its potential aquatic resources; we believe that a number of ways, at present entirely unsuspected, of using the waters of the world for the purpose of food production for man will be found in the future. There are great areas of inland and marine waters which are neglected, even by present-day methods. There are plants and animals of which no use is made at present, but which may become extremely useful.

Your Government is making efforts to bring about a proper utilization of resources which are at present neglected for social or technical reasons or because of lack of knowledge. Research is going ahead; great irrigation developments are taking place; exploratory operations are being unedrtaken at sea; neglected and derelict lands and waters are being reclaimed for effective use. It is not extravagant to expect that your Government should bring about a very significant increase in production within the near future.

Production of resources at present under exploitation can be increased by improvements in the overall utilization of resources : in technology, and in the resources themselves. These improvements fall into two categories; those which will bring about an increase in the yield per unit effort, and those which will bring about an increase in the yield per unit area. For situations as in India with small holdings and a large percentage of the population dependent on agriculture, the latter may be considered the more important.

There is no doubt that vast improvements can be effected by a well-prepared and thoroughly integrated plan of resource use. Each type of land (which includes the bodies of water) would be allotted to the use which would give the best yield in terms of the nature and quantity of the product, and of the effort required for its production. Such a plan would indicate the optimal land use pattern, the correct balance and integration between cultivated land and uncultivated land, the integration between systems of crop and animal husbandry, and the proportion of cultivated land which is to be used for food, fodder and cash crops.

The productive capacity of soils may be increased by fertilisation, by irrigation and by improved cultivation methods. The crops can be improved by breeding strains and varieties which are better adapted to specific environments, more disease resistant, and higher in yielding capacity. Cattle and other livestock can be improved by breeding to yield more animal products per animal, greater resistance to disease, and better adaptation to environment. Improved techniques in agriculture and animal husbandry, in management of soil, plant and animal, in protection against disease and adverse environments and in optimal utilization of the capacities of crops and livestock, combine to ensure greatly increased production per unit and as total.

Improving the productive capacity of soils by use of fertilisers is still a relatively unexplored field in India. Enough information, based on experiments, already exists to launch a country-wide program for the use of fertilisers. In the case of rice, the most important food crop, an application of 100 lb. of sulphate of ammonia to the acre, a very moderate dressing, could give at the present price levels of grain and fertiliser 100% return on the outlay. If the available supply of this fertiliser in the country, 400,000 tons, is used on rice the production could be expected to increase by 750,000 tons of rice. The wheat crop could be treated in the same way as the rice crop, and other food crops are sure to justify moderate use of fertiliser. Similarly, in States where plant breeding has gone ahead and improved varieties of crops are available to suit different areas of the States, properly organised seed projects should help in spreading the varieties over large areas and thus make a substantial contribution to increased production.

Inland aquatic resources can be improved by new techniques : the waters can be stocked, fertilized, cleared of noxious weeds, and otherwise improved; the fish can be selected and improved by breeding;; the fish stock can be fed, protected against predators, kept clear of disease and parasites and efficiently managed; the the stock of open water-ways can be conserved and generally developed. The marine aquatic resources lend themselves less readily to such direct intervention by man, and yet conservational practices would undoubtedly bring about improvements; there is evidence that new research work, and new technological methods will improve the management of these resources : it would be unwise to say that man will never make better use of the seas than by harvesting the crop which he has not sown : there is no reason to suppose that the tremendous reserves of nutrient materials in the seas will be available only through the hunting methods at present employed.

In the production process, the human factor is of overwhelming importance; it may not be an exaggeration to say that this factor more than any other determines the level of the production from any given area. The importance of the summation of the individual contribution to production has already been mentioned. The total production of any country is determined not by a few dramatically successful efforts but by the persistent and earnest efforts of individual people and this individual contribution depends upon the competence and the enthusiasm of the individual. A very good soil or a rich pond may be valueless in the hands of a careless or uninterested producer; although the most skilful and enthusiastic worker can make little of a poor resource, on the average the more competent and enthusiastic the worker the greater the production. While we must ensure that adequate equipment is placed in the hands of the operatives, it is of greater importance that we help them to improve their education and their technical skill and that we convince them that it is important that they improve and inensify their operations. How this is to be done will vary perhaps from district to district but it means that much attention must be given to extension work and to the problem of incentives.

Though India may be slightly better off than other countries of this region, we realize that she does not have sufficient extension personnel. Success in extension depends not only on frequent contacts between the extension officer and the farmer but also on the special officer being sufficiently trained so that he can communicate his ideas to the farmer. The new community centres where extension staff are being trained may improve the situation. The question of incentives is also important but the form and degree of incentives will have to be carefully considered lest they should have undesirable consequences. Even credit facilities could prove sufficient incentives in some cases.

Improvement of supplies

This may be approached from two angles. It may apply to such things as fertiliser and seeds; frequently when supplies are available, they may not reach the small, relatively isolated farmers in time to meet their needs. A sound organization is necessary to channel the supplies down rapidly to the ultimate users. Sometimes, even when a farmer is convinced of the benefits of adopting a new practice such as the use of a particular fertiliser, he may not have the ready cash to buy the fertiliser. Supply to him thus requires easy credit facilities or delayed payments.

There is also the question of the improvement of supplies of foods which reach the consumer, improvements in the quality of the product by improved production, processing or storage methods. In this connection we may refer to the excellent work of the Bombay Milk Scheme in achieving the twofold objective of clearing up this City by removal of dairies to a site outside the urban areas, and of providing the citizens of Bombay with a clean milk supply. Similar developments in Calcutta and the other great cities of India would be a great contribution to the improvement of supply of this particular commodity.

Protection of supplies

Spoilage and wastage greatly reduce the quantities of food which reach the consumer. We may consider these losses under three heads: losses due to depredations of insects, rats and other pests, losses due to bad processing, and losses due to spoilage of product with age. The losses which occur as a result of the activities of animals of various kinds which take place in the field, in storage and during transport are very considerable. It is difficult to make an accurate estimate of the exact proportion but there is no doubt that prevention of such losses would considerably increase and improve the quantities received by the consumer. Losses due to bad and inefficient processing include those which occur in the milling of rice, in the treatment of fish, and so forth. Fortunately all these causes of losses can be virtually eliminated.

There are also the losses caused by bad cooking and inefficient domestic practices in the home of the consumer. Again, it would be extremely difficult to attempt to estimate the quantities of foodstuffs lost by such carelessness; it is not merely complete loss of quantities of food, but also loss of nutritive value because of poor cooking. Improvement in the present position could only come about by education, particularly of the younger generation.

Control of supplies

In the present situation in which supplies do not meet the needs of the nation, it is obviously necessary that Government should intervene to control the movement and distribution of available supplies. The system of control will relate to the major movements as between surplus and deficit areas and to the allocation of supplies to the individual level, that is, rationing. Undoubtedly such controls are irksome and are at times economically inexpedient. They involve much administration and may be extremely expensive. Nevertheless they are unavoidable. However, the most efficacious mode of control on the use of supplies is that which is exercised by the individual. It is essential that a nation as a whole should adopt an attitude of frugality towards its food supplies.

The Overall Plan

Although the provision of food supplies is a considerable problem it is, of course, only part of the full range of problems of this great country. Housing, clothing and other material wants claim their share of national attention; medical, educational, and other services occupy the time of many; and thus it goes on through an endless variety of human needs and corresponding occupations and claims upon national resources. The national food plan cannot be considered in isolation, but must be developed as part of the total economy. There are three principal lines of thought which we might follow at this stage.

First : the general policy of the country in respect of its principal objectives in terms of standards of living and its relationships with its neighbours. These policy decisions determine the relative weight to be given to food industries as against other industries, and the problem is exemplified by such expressions as "guns and butter"; they involve determination of the best allocation of national resources, directly to food production, indirectly to food production by the production of commodities which can be exported in exchange for foodstuffs, and to the production of non-food commodities. Although your Government has set a target of self-sufficiency in food production, it may later emerge that such a national plan is impracticable and that reliance on imports must become a permanent feature of national policy. The pace at which industrialization is taking place in India adds weight to this thought and prompts the further question whether such industrial development is leading toward a true balance of your economy.

Second : at this general level we should consider the operation of food industries within the national context. I have already spoken of the problem of convincing the operatives of the food industries of the need to intensify and extend their operations in order to bring about production increase. This cannot be merely a matter of words : incentives for increased effort must be real to the individual operative and they must be realistic within the community of which he is part. On the one hand, the producer must be enabled to dispose effectively of his products and to obtain for them a price whch makes him as well paid for his labour as other workers of the community. He must not be in the lower ranks of wage earners. On the other hand, he must have access to and a desire for an adequate range of consumer goods over and above his bare necessities. The desire for these goods implies in him an educational status at least equivalent to the general average of the community to which he belongs. Therefore the educational programs of the national must be designed for and available to the operatives of the food industries. If it should be that these operatives are less literate than other operatives, then if food production is given a high priority in the national program the education of these operatives should have a priority over and above that of other operatives corresponding to the importance of this objective.

Third : we should consider the purchasing power of the consumer. I have mentioned earlier the simple fact that a consumer without purchasing power is *de facto* not a consumer, but assuming that steps can be taken to ensure that the consumers do have purchasing powers, there is a further obligation to ensure that this purchasing power shall be at a level to give the producer an adequate price.

2. R. O. Whyte of F.A.O.

No discussion of this great problem would be complete without reference to the livestock of India, and particularly to the working bullock and the cow, which "bear on their patient backs the whole weight of Indian agriculture" (Lord Linlithgow). The Joint Committee of the Indian Councils of Medical Research and Agricultural Research have recently drawn attention to this aspect in their Draft Memorandum. This states that the emphasis on food crop cultivation in recent years has tended to ignore the nutritional demands of the livestock without which the production of food crops and the protein nutrition of the village people would not be possible.

The veterinary specialists and animal breeders of India have made great progress in their respective and relatively more technical fields; knowledge has been accumulated on the scientific aspects of animal nutrition, and on the characteristics and breeding possibilities of India's excellent breeds of livestock. But there has been little work on the more practical questions on improved, indigenous methods of stock husbandry, on the relative merits and possibilities of stall or dry-lot feeding, controlled grazing management, and so forth.

The present systems of village cattle keeping and of free range grazing have arisen in a haphazard manner and are out of line with present knowledge of standards of nutrition, integration of crop and livestock husbandry, land utilization, and the conservation of vegetative cover and the soil below it. Better control of livestock movements and feeding techniques would make the greatest contribution to the conservation of soil referred to by the Governor of Uttar Pradesh in his opening address to this Congress.

Nor does my own particular field of work, the provision of feed for animals from natural grazing lands or cultivated fodder crops, exist as a recognised branch of Indian agricultural science. I firmly believe that if proper attention were given to these twin pillars of an improved land use system, namely, systems of animal husbandry in relation to grassland management and fodder production, a great contribution would be made to the reduction of India's food deficit by the improved farming systems which could be developed.

This problem is being approached in two main ways : *first,* by the preparation of a book to be published by the Indian Council of Agricultural Research bringing together the present state of our knowledge on "The Grassland and Fodder Resources of India" and indicating what the future trend of research, administrative action and land management policies might be under the very specialized conditions of India; *second,* by the initiation of a co-ordinated scheme for research and practical measures for improved grassland management and fodder production, with allowance for full collaboration between the Centre and the States.

It is our hope that the grassland ecologists and fodder agronomists may in due course be in a position to suggest to the animal husbandmen some alternative ways of keeping livestock, in relation to the type and quality of fodder and grazing which they can provide. It is fully realized that the work must be pressed forward in a most frustrating of atmospheres dominated by great social, administrative and religious difficulties.

3. P. N. NANDA (New Delhi) :

In the common parlour of the post-war period, the term "food" has apparently acquired a limited connotation and has gradually come to mean only grains like wheat and rice. To a certain extent, this narrowing down of the definition is understandable, because, in the frantic attempt for filling up the gap between availability and requirements, the emphasis has naturally to be on quantity rather than on quality. This has resulted in food of animal origin, particularly milk and milk products, being ignored. It is a matter of common knowledge, however, that the large majority of the population in India are vegetarians, to whom the only source of animal protein in their diets is milk and milk products.

Few seem to realize that in the food of animal origin, India has a large unexplored field. This country has the largest cattle population of all countries of the world, owning as it does, about a quarter of the world's total bovine population. These animals have proved potentialities for increased production and it has been found that proper feeding alone can bring about an immediae increase of about 50% in the existing production. At present, the available supplies of milk and milk products amount to only about 5 oz. per head per day of the human population. A 50 per cent increase in this will obviously mean a substantial addition not only in quantity but also in quality of the poor diet used in India. Nutrition experts have put down that the minimum requirement of milk by the human beings is about 16 oz. per head per day. Even if half this quantity be provided by the provision of more food to the animals, it really deserves better attention and effort.

The greatest handicap to increase in animal production, is the absence of sufficient cattle feeds. It is estimated that the available concentrates will suffice for only about 28 per cent of the existing cattle population, while the available supplies of roughages will suffice only for about 78 per cent.

Although India owns a number of first class cattle, many of them are in an undeveloped state and a large number of them are uneconomic producers. Some of these are also diseased and decrepit, whose slaughter is prohibited by sentiment. These latter scramble for the scanty supplies available, leading to the worsening of the feed situation, and to the general deterioration of the entire population.

In connection with the improvement of cattle feeds, the most pressing problem, apart from the difficulties mentioned above, is the problem of the uneconomic and surplus cattle. According to the present habits of the people, all animals are let out into the grazing areas, where grazing is free. No limit is placed on the number and type of animals which an individual should maintain. This unfortunate position is likely to be aggravated with the ban on slaughter of cattle now being introduced in a number of States. It would thus seem that unless the available feeds are utilized for the feeding only of economic producers, the position would become really serious during the course of next few years. A possible solution, which under the existing circumstances, needs careful examination, is that all grazing should be prohibited by law and all animals should be stall-fed. This would immediately force owners to dispose of surplus animals, and only productive and economic animals would be maintained. Smaller numbers would mean better and adequate feeding and this would make up the deficiency in numbers and not only maintain but increase production for human consumption.

4. S. L. Hora (Calcutta) :

When during the World War II, outside markets for supply of rice and wheat became inaccessible to India, the problem of deficiency of food arose. Instead of examining all the factors that caused the deficiency, India started "Grow More Food" campaigns, but these have not so far yielded the expected results. Deficiency could be checked by properly conserving and utilizing what was being produced already. But unfortunately this aspect of the problem received scant attention, and is still being neglected. Our "Grow More Food" has failed because we have attempted to execute schemes foreign to this country and without harnessing our traditional knowledge and skill. Attempt should be made to supply the farmer what *he needs* and not to foster on him new appliances which may not be in harmony with the rural economy of India. Evolution rather than revolution should have been our watch-word. Let us still try to understand our traditional practices and expand them in the light of modern scientific understanding.

The above remarks were illustrated with specific examples from the author's own experience in fisheries development.

5. B. C. Guha (Calcutta) :

Food shortage in India has often been blamed on her large population. While, no doubt, a certain limitation on the growth of population is desirable so that the food problem may not be aggravated, it would appear that the real solution of the problem lies in the scientific development of India's resources and an equitable distribution of the foodstuffs produced. The production of rice per acre in India is of the order of 750 lbs., whereas in other countries it is double, treble and sometimes quadruple. With the use of better varieties of seeds, irrigation, natural and synthetic fertilizers, and rotation of crops it seems feasible to step up food production considerably within a limited period. The food deficit should not, however, be considered only in relation to the cereals but also in relation to the production of the so-called protective foodstuffs. In fact, any food production plan must be balanced and comprehensive. If pursued with vigour and if the economic system is adjusted to the requirements of production and proper distribution, such a food plan can solve the problem.

6. A. K. Mitra (Kanpur) :

The problem of solving our food difficulties in spite of the losses caused by various animal and insect pests and diseases, lies firstly in directing an all out effort to assure water supplies. Without adequate water supplies manuring brings in practically no returns and is a waste. With assured water supplies our food production can be immediately stepped up by easily 50% or even more.

Secondly, an adjusted changeover to greater production of protective foods should be made. Besides protective foods of animal origin such as meat, fish, eggs, milk, etc., those vegetable origin particularly the Potato is a highly important one. Potato is both an energy producing as well as a protective food. Supplemented with milk, it forms the complete food for man. Besides, from the food value point of view, an acre of Potato is equivalent to at least three acres of cereals like wheat, barley, or paddy.

Thirdly, in view of the complexities and difficulties in the application of chemical measures of Pests and disease control, greater attention should be directed towards evolving simple cultural methods which any grower can easily take up anywhere.

While the control of population is important it must be remembered that according to biological laws, improved nutritional and living standards automatically lower rate of multiplication.

7. N. K. **Panikkar** (Mandapam) :

The importance of increasing the production of cereals has been indicated in the various previous contributions. In addition to cereals protective foods like milk, fish, meat, poultry and others require equal attention and these remarks are specially made in reference to fish production. India produces annually between six to seven lakhs of metric tons of fish per annum. Although the major share in total production comes from the sea, sea fish are not used to the full extent in the absence of facilities for transporting fish in a fresh state to the interior and in the absence of advanced processing or cold storage facilities. In increasing the fish supplies of the country it is a question of better utilization so far as sea fisheries are concerned, although the sea fisheries also provide means of expansion by off-shore fishing. On the other hand the fish production of fresh-waters has a great part to play in the rural economy because freshwater fish form a commodity directly consumed by the people in a fresh state. Here the increased production is possible by better cultural practices in ponds, and more and efficient and regulated methods of fishing in rivers and lakes. It may thus be seen that both the culture fisheries of the inland waters and the capture fisheries of the seas offer possibilities of expansion. In the subject of food production it is also essential for us to remember that improvements should be simultaneous in the various sectors and any programme to improve supplies of food should be integrated so as to pay attention to the various sectors, *viz.*, production, handling, processing, distribution, marketing and storage. The need for integrated approach to problems of food production requires special emphasis.

8. K. P. **Basu** (Bangalore) :

A diet for optimum health has to be based on much less cereals than 14 oz. per capita per day and the intake of dairy products and animal foods per day has to be considerably enhanced over the amounts given in the Nutrition Advisory Committee report. Even if the amount of cereals made available per adult be raised to one lb. or *ad lib* amount per day, the health of our people will suffer if they cannot get sufficient amounts of protective foods like dairy products, animal foods, fresh fruits and vegetables. Although their hunger will be satisfied, the health and growth of the people, specially of the children, will be poor and they will fall prey to all sorts of diseases. This has been very vividly shown in an investigation carried out by the author in which experimental animals had *ad-libitum* access to the typical rice diet and still grew very poorly. Supplementation of milk to the diet had remarkable balancing effect.

The target with regard to the cereal and grains may be attained in about five years' time if the measures recommended in the Five Year Plan are adopted. Special measures for the attainment of the Target with regard to foods of animal origin are urgently required. It is unfortunate that the Five Year Plan has not recommended any measure for this purpose. In my opinion particular stress should be laid on measures to increase the supply of milk, fish, meat and eggs even if it means that thereby the production of cereals and grains may not increase as envisaged or even if the production of cereals remained stationery. Greater availability of milk, fish, meat and eggs would decrease the demand for cereals and would at the same time vastly improve the nutritive value of our diets.

After feeding the bullocks used for ploughing the lands, insufficient amounts are available for feeding livestock to produce milk, meat, eggs etc. The resources of animals feeding stuffs for production of milk, meat, eggs etc. should be increased by the following measures :

(*a*) By the introduction of tractors for ploughing the land and eliminating the use of bullocks for this purpose. We can never dream of self-sufficiency in human food requirements, if with the existing pressure on lands we have, besides feeding the milch cattle which we must do for the production of milk which is such an important item in the dietary have to feed the bullocks whose work can be done by machines. The introduction of tractors would necessitate consolidation of holdings or tilling the land on a co-operative basis. These measures cannot be postponed if we want to survive. Railways, cars and buses were introduced into this country without manufacturing them in the country itself. This should also be possible with tractors. The problem of fuel is of course important but is not one which is not capable of solution. It is also not possible to bring the vast areas of fallow and cultivable waste land in the country under cultivation without the use of tractors. All the food now being used for feeding bullocks should ultimately be used for feeding milch cattle and their followers, poultry and animals for meat production.

(*b*) By reserving a part of the cultivated lands for production of fodders for milch cattle.

(*c*) By tapping all available grazing resources, *e.g.*, forest areas, cultivable waste and fallow land.

(*d*) By converting the surplus of green grass in the areas mentioned above into hay.

(*e*) Bran should be prepared and utilised for feeding livestock. At present the dehusked and unpolished cereal grains that are being supplied from ration shops are being polished by consumers and the bran is being entirely lost. While too much polishing results in a loss of some valuable nutrients from cereals, it may be stated that bran contains about 11-12 p.c. fibres and 4 p.c. silica and has a digestibility of only 45 p.c. or less. It is no good food for human beings but is very suitable for animals.

It will not be feasible to raise the area of cultivated areas in India to 400 million acres in near future. The distribution of 312 million acres of land likely to be available for cultivation purposes should, in my opinion, be as follows :

A.	(*a*) For cereals and millets	160	million	acres.
	(*b*) For vegetable oil or edible oil seeds ...	60	,,	,,
	(*c*) For pulses and grams	35	,,	,,
	(*d*) For vegetables & fruits	6	,,	,,
	(*e*) For sugar and Jaggery	4	,,	,,
	Total for foods of plant origin	265	,,	,,
B.	For cash crops like Jute plant origin ...	27	,,	,,
C.	For cultivation of fodder for milch cattle ...	20	,,	,,
	Total ...	312	,,	,,

If it is not possible to meet our needs for cereals and millets from 160 million acres with the introduction of improved methods of agriculture, we should not hesitate to import a part—indeed it is only a very small part of our requirements of these grains. As more lands over 312 million acres become available, these should be devoted to growing oil seeds and fodder.

Both proper breeding as well as better feeding are required to increase yields from animals and their work efficiency. It is well-established that food required for the maintenance of both heavy and poor performers of the same weight is the same. Additional food is required only for the extra milk yield or the greater amount of work done. It is most uneconomical to maintain poor performers. While providing for food for extra milk and work for our animals by a proper and sound breeding policy, as quite an appreciable fraction of our animals have so degenerated that extra feed cannot get more milk or more work out of these animals.

Elimination of useless and unproductive animals is essential.

9. D. V. Karmarkar (New Delhi) :

There was no difference of opinion that there was food deficit in this country. The deficit was not only in cereals but also in other protective foods, like fruits, vegetables, eggs, milk, fat etc. One could say that our fore-fathers were responsible for the present catastrophe on account of their obliging and hospitable nature. Not only they allowed the original inhabitants of this country to live and flourish but they kept an open door for new comers, foe or friend. Whatever may be said about the effects of controlling the population by birth control measures, it was difficult to effect an appreciable reduction in the population for some time to come. Indeed it was doubtful if we could make use of the costly appliances in the face of our low average yearly income. Moreover, we were receiving back into this country our own countrymen who had spent their lives abroad and tried to develop the agriculture in other countries. What is meant by the term 'self-sufficiency in food' as used at present, is only self-sufficiency in cereals. Various recommendations have been made from time to time to increase our yields and to reduce our wastage. We have been trying everything that is possible to follow these recommendations and we could say that there has been not much of a wastage, to say the area under cultivation is limited and the population is large. It should be the duty of the F.A.O. to organize the production and distribution of food so that the countries which are deficient in it get their quota based on population. The country receiving food in this way should be prepared to give assistance in man-power and other materials, if necessary. The question of self-sufficiency in food has been raised under compulsion because it was considered necessary at least to have the cereals produced in the country to feed the masses and one should not be required to depend on other countries for this minimum requirement. People in a country cannot, however, live only on cereals and at least that is not the goal to be looked for. We must have the other necessities of life which would enable us to live a better and cultured life. For this purpose it is necessary for this country to produce what it could do in the best way and to exchange it with other countries for foodstuffs which they grow with ease and in plenty. In this respect the F.A.O. should be of use.

He also laid emphasis on the necessity of changing the dietary habits of the people. He said that it was necessary that there should be as few a food products as possible which are not acceptable by a class of the population. All sections of the population should be in a position to consume any food of good quality which is made available. Limitations in the acceptance of foodstuffs caused an unnecessary hindrance in the distribution of food.

10. P. K. Bose (Calcutta) :

For a long time it has been a debatable point whether India is deficit with regard to food or not. There are two opinions about it. In this short review he has tried to construct an 'Index' which determines the position of a country with regard to food. Analysing this 'Index' he discussed that the different components which are essential for the calculation of this 'Index' are not known with sufficient precision in India so that a correct estimation is not possible with regard to the problem of food deficit. In order to tackle this problem effectively the components have to be determined with greater precision.

11. N. V. R. Subramanyam (Dhanbad) :

During the last few centuries, increase in food production has kept pace with increase in population, mainly by extending the area of food-producing land. But, the mainstay for the maintenance of population in future years should emerge from intensifying production on already developed land. But, neither the productivity of the land is into perpetuity, nor is it possible to equate the economic productivity of land with its potential productivity. Besides are the alarming factors of soil erosion and resultant decline in the fertility of the soil.

These observations hold good in our country too, without any qualification. For proper correlation of such conflicting factors and timely co-ordination of activities for improving and stabilising the food production in our country, I give below a few suggestions :

1. As the formation of soil and its characteristics are dependent upon a complex set of circumstances, efforts should be made to classify soils according to soil profiles. Such data undoubtedly afford necessary information about the suitability of any particular soil for a particular crop and also, about the potential productivity of the different soils in the country. Every region should be given due consideration in solving the problems peculiar to each one of them.
2. It is not enough to confine soil conservation measures to hilly regions or to those areas of deforestation, where the rate of soil erosion is at its maximum. It has to be appreciated that even in ordinary cultivable lands, the fertility of the land has to be kept up in a sustained manner. This can be done in an efficient way, by resort to a planned system of crop rotation (grass is also a crop for this purpose), and to terracing and contouring the fields properly.
3. The exact nature of soils in each zone or under a village has to be enquired into and proper methods of improving the texture of the soil by the application of natural measures should be encouraged. Artificial fertilisers cannot solve the problem of guarding the fertility of the soil. At best, the artificial fertilisers can only act as stimulants and there is every difference between a stimulant and food for the soil in healthy maintenance of crops.
4. It is not necessary always to look upon the Multipurpose projects as the only saviours of the food situation in our country. Difficulties (especially financial and technical) in the way of planning and execution of such huge and costly projects are now being well realised. This explains the swing in the popular opinion and practice towards community projects in our country, of late. The activities of such community projects should include finding out suitable sites for the construction of small reservoirs and tanks for storing rain water for irrigation purposes; and also, the ground water conditions in such localities. Measures may be evolved

to prevent the rapid silting up of the existing system of tanks, etc. especially, where other facilities for irrigation do not exist.

5. It will not suffice if the programme contained in these suggestions, are left entirely to the hands of Agricultural science. The field problems, such as, the soil survey and soil analysis, soil erosion and conservation, investigations about ground water conditions and selection of suitable sites for small reservoirs and tanks for irrigation purposes should be left to he Geological Science. The Geologists are thus ideally suited to contribute in their own humble way towards the solution of food deficit in our country.

12. M. N. Varma (Nagpur) :

It was presumed that after Independence the problems with which our country was faced would vanish. We have been able to combat many evils no doubt, but the biggest problem, which we have not been able to solve, is of *food*.

The population of both the men and the animals has increased tremendously. One per cent in each case annual increase whereas land remained the same. From 1940 to 1950 population increased about 30 millions. Only 207 million acres are cultivated land which accounts for ·6 acres of land per head. In western countries this figure is 3, 4, or even 5 times.

In our country the chief concern is between the population and yield of our harvest as well as between the population and our national wealth. Our country suffers from chronic poverty and low yield is the direct result of this poverty. Another problem is the consolidation of holdings and too much conservatism. Belief in doing what one's neighbour does.

Problem of soil erosion is another nerve taking. Remedies suggested—Addition in the agricultural lands especially in the Five Years' Plan—Different River Valley schemes will add up more land,—use of fertilizers, manures and machines.

Last but not the least is our moral problem—Statistics correct to the farthest degree—Thus in order to solve our food deficit we should not depend on the benevolent charity from the dollar or the sterling areas rather we should try to raise our moral standard combined with the measures suggested above in the right way.

13. Dr. C. C. Shah (Anand) :

Various measures have been suggested by the previous speakers for increasing our crop yields. If we however survey our experience of the last few years, we invariably find that the low yields are invariably due to either late onset of monsoon or failure of late rains. Either of these causes places a permanent setback on the growth of the plant and leads to reduced yields. With proper irrigation facilities phenomenal increases in yields have been reported from every province. The major controlling factor therefore appears to be water supply.

With the advent of the larger irrigation projects, a large part of the cultivable land would be brought under irrigation, but even on the completion of the Five Year Plan we are not likely to bring more than fifty per cent of our arable land under irrigation. The vagaries of the monsoon will even then affect fifty per cent of our crops and our average yields will tend to remain low.

So long as monsoon is not under our control, and artificial rain making within the reach of average farmer, we must depend on supplementary irrigation to tide over adverse monsoon conditions. Minor irrigation projects have been receiving increasing attention and it is in the fitness of things that they should. If we can so arrange our water supply, that every acre of land in the country can be given just one irrigation, at the right moment in the physiological life of the plant, it would make an immense difference in the picture of our crop yields.

The solution of food deficit problem lies in the supply of water and water alone. Other measures will certainly increase our crop yields to still higher levels, but an inadequate supply of water made by capricious monsoons can never assure an adequite yield and must not be depended on. The problem of supplying water to every acre seems colossal, but that is the solution. It may take five, ten—nay fifty years, but it is a must and then only the farmer can be assured his higher yields. If encouragement and co-operation is given to the farmer to tap available water supplies at a little more extra labour and expense, the problem seems feasible of solution. There should be a source of water within the reach of every ten acres of land. If the source of water is large, one may be sufficient for a larger area. When water is badly needed, the whole village will act as a unit and with the available resources would be able to tide over a dry period. So long as we have to depend on the monsoon for our crops' water supply, this is the only right solution for assuring our yields and wiping out our food-deficit.

14. N. K. Roy (Calcutta) :

Food problem is the worst problem which has been taxing the best brains for all time past and present and will continue to be of utmost importance so long the human race continues in its march of scientific progress. Death control—the spectacular effect of preventive medicine and other health measures—is sure to baffle all attempts of birth control. So if we are to face the food problem, we must take a back sight and foresight as we do while shooting a rifle. Back sight is history and foresight is our present scientific knowledge for improving production, preservation etc. From back sight we learn that whenever there was scarcity of food a shift from the usual saved the situation, and it is now essential that an all round attempt for a shift should be made—like of which had already been advised by the present Rajyapal of Uttar Pradesh when he was Food Minister of the Union.

In winding up the discussion Dr. Kehar remarked that we have listened to the views of the specialists connected directly or indirectly with the production of food for human population.

He strongly felt that with the proper re-orientation in the pattern of land usage and improved livestock, not only the produce will be augmented but the nutritional value of our diet and thereby the health of the nation will undoubtedly improve. He, however, stressed that the remedy to meet shortages is to grow more food. But in so doing equal stress must be laid on the improvement of livestock and the enrichment and conservation of soil and vegetation.

Dr. Kehar further suggested that the most important part in any scheme of such extensive application is the role played by the enthusiasm and support of the general public. The public is to be educated by all types of propaganda about the gravity of the problem.

It was resollved that the proceedings of this symposium should be brought to the notice of the authorities concerned so that advantage is taken of the views of scientists engaged on different aspects of food production.

XIX. THE PHYSIOLOGICAL EFFICIENCY OF MAN AND ANIMAL AS CONDITIONED BY CLIMATOLOGY AND NUTRITION.

Section of Physiology

Chairman—Dr. N. D. Kehar, Izatnagar.

Inaugurating the symposium on the physiological efficiency of man and animal as conditioned by climatology and nutrition Dr. Kehar pointed out that favourable environmental condition play a very important role in attaining optimum production of animal products like milk, meat and eggs and also in maintaining the efficiency of a man for productive work.

Dr. Kehar narrated the interesting observations obtained in his laboratory on the effect of climate and humidity on the physiological reactions of different species and different breeds of animals and showed how under conditions of comforts the intake of adequate amounts of nutrients and also the productive capacity of animals can be maintained at an optimum level. The wide variations both in temperature and humidity operating in different parts of this country suggest that a thorough investigation over the conditions under which particular breeds of animals can thrive best needs immediate investigation. Although improvised methods were devised to simulate the varied environmental conditions but for more accurate work a temperature and climate controlled laboratory is very essential. These findings will give us a correct idea about teh location of a particular breed under particular environmental conditions. He further remarked that when cattle and buffaloes are exposed to direct sun rays the efficiency of the heat regulating mechanism was more effective in the case of cattle than buffaloes. But when they are protected from the direct rays of the sun the efficiency of heat regulating mechanism of buffalo was found to be better.

He then requested eminent workers in this field to express their views.

1. Dr. B. K. Anand (New Delhi) :

Dr. Anand pointed out that the lateral area in the hypothalamus could be designated as the "Feeding centre". This centre controls the 'Central hunger mechanism' or it provides the urge to eat in the animals. The medial hypothalamic area produces inhibitory influence over the 'feeding centre'. Electrical stimulation of feeding centre increases the intake of milk and meat (500-700%) in the animals and when the stimulation is stopped, the feed intake drops down to normal. On stimulation of other hypothalamic and nervous area, no change in food intake occurs.

2. Dr. S. L. Hora (Calcutta) :

Speaking in terms of modern biological sciences, one may say that the study of no organism, including man, can complete without a knowledge of its ecology. Environment is thus as important a part of the organism as the organism itself. Climate has been found to be the most important factor of any environment. It appears that the changes of climate cause corresponding changes, not only in the distribution of man, but also in his occupation, habits and even characters.

Nutrition depends on the availability or production of food which is governed by climate. Thus nutrition and climate can in terms of human and animal physiology be almost regarded as synonymous. Milder and more equable climates, with greater precipitation and less evaporation, have been responsible for the progress of human civilization. All available data show that upto the 3rd or 4th Century A.D. India had a mild climate and there was then plenty of food and opportunities for all. That is regarded as the most glorious period of India's history. From the above remarks, it will be clear that the physiological efficiency of man is conditioned by climate, indirectly as well as directly.

3. Dr. J. D. Findlay, Scotland (In absentia).

The histological studies of the bovine skin, Ayrshire and Zebus from Sudan and Jamaica, revealed that the difference in heat tolerance adaptability to high temperature can be explained in terms of structurally different sweating elements in the skin or in the density and distribution of these elements. The blood supply in the skin of Ayrshire calves leads to the deduction that this breed is ill adapted for resistance to heat. The deep pigmentation of the Zebu may be a protection against intense solar radiation.

Preliminary studies on Ayrshire calves from 4-6 months old in the climate chamber have indicated that (1) more than 6 hours exposures are necessary to have any change in the respiration rate, pulse rate and body temperature of the animals, (2) respiration rate of the animals increased markedly with increased environmental temperature. The maximum rate of change in the range of 25 to 35°C. (3) At 40°C., a large increase in humidity put great stress on the animals, and tenfold increases in respiration rate were noted.

4. Dr. D. P. Sadhu (Calcutta) :

There are several categories of efficiency such as work, growth, conversion process etc. The author describes the different classification of efficiency and they are as gross efficiency, net efficiency and absolute efficiency. He describes the efficiency as conditioned by climatology by saying that heat loss depends on the available body surface and under normal circumstances heat production equals heat loss. Heat production due to SDA cannot be utilised for work but can contribute to increase body heat in cold climate. SDA reduces the efficiency in hot climates to a very great extent. It is described that efficiency is conditioned by nutrition; as the plane of nutrition increases efficiency of utilisation of nutrients progressively decreases. The greatest single factor in decreasing the efficiency is SDA. He recommended that in both human and animal feeding, the plane of nutrition should be kept at an optimum level for the maximum physiological efficiency.

5. Professor H. H. Mitchell, U.S.A. (In absentia).

The most important information on the relationship between nutrition and climatic stress involve the body's requirements for energy and for water. Under stress, as under non-stress conditions, changes in energy and water requirements are indicated over a period of time by corresponding changes in the appetite for food and the thirst for water. These physiological urges, assuming that liberal amounts of food and water are available will in the normal man provide adequately for the changed needs for energy and for water brought about by climatic changes. This may not be immediately true under tropical conditions that tend to depress appetite, but as acclimatization progress this difficulty may disappear. The provision of highly acceptable and appetizing foods will aid greatly in such a situation.

He further pointed out Johnson and Kark have provided quantitative information on the effect of environmental temperature on the energy requirements of man, The average caloric intakes for groups of 50 to 200 service men in many different climates throughout the world war plotted against mean environmental temperature, which ranged from −30°F. to +92°F. The men received ample rations of wide variety and showed no signs of nutritional deficiency. They carried out much the same tasks in all cases and were clothed in a manner appropriate to the climate in which they lived. There was a high correlation of voluntary intake of food energy and prevailing environmental temperature. The regression equation is linear and its slope indicates an average change of 15·5 cals. per man per day per °F. change in ambient temperature. The regression equation is $C=4641-15{\cdot}48t$ in which C=calories per day for a man weighing about 70 kgms. and t=the mean environmental temperature in degrees F. Later work, from the same laboratory, indicates that about two-thirds of this climatic effect is due to the appropriate changes made in clothing assemblages with changes in climate; the heavier the clothing the greater its hobbling effect on the movements of the body.

When the caloric requirements change, the requirements for many of the micronutrients will change also, since they function in the metabolism of the main organic nutrients in providing energy to the body by promoting oxidative enzyme reactions.

Sweat seems to contain all the nutrients and metabolities contained in the blood plasma, though in different concentrations. The losses of most of these nutrients in the sweat is inconsiderable compared with requirements, except for sodium chloride, iodine, iron and calcium. While information on the losses of these nutrients, including compensatory changes in urinary output, is not complete, a conservative evaluation of the evidence at hand would warrant added emphasis in the use of iodized salt in a sweating environment and greater attention to the intakes of high-iron and high-calcium foods.

The effects of changes in the proportions of protein, carbohydrate and fat in the diet on tolerance to cold are undoubtedly real.

When the usual proportions of these organic nutrients in the diet are disturbed by raising the content of protein at the expense of carbohydrate, the resulting diet will tend to be less efficient in protecting men against the damaging effects of cold, both to the heat economy of the body and to its efficiency in carrying out manual, mental and sensory tasks. When the proportion of fat is increased at the expense of carbohydrates, the diet tends to be more efficient in combating cold, especially when the intervals between meals are shortened.

The effect of such dietary modifications on the tolerance of man to heat has not yet been studied in the laboratory to a sufficient extent to warrant the formulation of definite conclusion.

The vitamins seem to confer no clearly marked or considerable effects on tolerance to climatic stress in man when consumed in amounts exceeding the demonstrated requirements in a non-stress environment.

6. Dr. D. N. Mullick, Izatnagar and Professor S. Brody, U.S.A.

In the United States, with the aid of scientific knowledge and enterprise, cows can produce some 55 qt. of milk a day; hen lay an egg almost every day in the year, still the hot weather is a more serious obstacle to maintain the optimum production than is cold weather.

No matter how good the inheritance and feed supply, an animal cannot attain a high productive level when the environmental temperature is near to that of the body.

Considering the importance of science of climatology in the improvement of the livestock population, Food and Agriculture Organisation of the United Nations took active interest for the improvement of the livestock population of the tropical and sub-tropical countries.

Not only the higher temperature menace is a serious obstacle to the efficiency for optimum production in the animals but also to the soil fertility and crop production.

The lower efficiency of all productions *e.g.*, milk, meat, semen and work under tropical and sub-tropical conditions may be directly associated with the decline in feed consumption.

From an engineering viewpoint it may be said that warm blooded animals are machines that are made to function within sharply defined temperature limits which may be called, the 'zone of thermal neutrality' or 'comfort zone' and that they over-heat and rapidly deteriorate, often breakdown, outside these temperature limits; and that the fuel (food) intake is automatically reduced by some thermostat in hot environments to avoid over-heating the machine.

Increasing the temperature from 50 to 105°F. seriously affects bovines rectal temperature, respiration rate and heat production, rise in these reactions are different in different species and in different breeds of the same species. The Indian cows lagged behind the European by about 15°F. in their rise in rectal temperature and other physiological reactions, due to 12 per cent greater surface area per unit weight, lower heat production, mostly because of lower productivity and possibly lower basal metabolism.

Feed consumption, milk production, and thyroid activity function within the given limits as mechanisms of body temperature regulation. Thus the combined effect of all these mechanisms of body temperature regulations limits the efficiency of productive performances of the animal under tropical and sub-tropical conditions.

7. PROFESSOR MAX KLEIBER, U.S.A. (In absentia) :

The most general basis for expressing efficiency of food utilisation is energy, chemical energy of the food, chemical energy of the animal product, such as milk, eggs, body substance, work and heat.

From the total amount of food energy taken in per day, I, the animal requires a certain amount, M, for maintenance. The rest, I-M is available for production, by Kellner called "Produktionfutter". The actual production, however, is only a fraction of the food energy available for production.

$$G = \bar{e}\ (I-M)$$

where G = rate of production in Kcal of chemical energy in milk or eggs or body substance per day.

I = rate of intake of food energy per day.

M = food energy required for maintenance per day.

ē = mean partial efficiency of food utilization.

For food utilization above the critical environmental temperature one may thus formulate.

$$\frac{G}{L} = \bar{e} - \frac{70\ W^{3/4}}{I}$$

G = rate of production.

I = rate of intake of food energy per day.

W = stands for body weight in kg.

If rate of gain and food intake are expressed per unit of the metabolic body size ($W^{\frac{3}{4}}$), the total efficiency may be formulated as follows :—

$$\frac{G/W^{3/4}}{I/W^{3/4}} = \bar{e} - \frac{70^{3/4}}{I/W}$$

The rate of animal heat production, however, follows the heat requirement only at a low environmental temperature. If the environmental temperature rises above a certain so-called "critical temperature" the rate of heat production of the animal does no more decline with increasing environmental temperature but becomes independent of the changes in environmental temperature. For the fasting animal on the scheme, this critical temperature is at 20°C. If the environmental temperature rises above a given upper limit, the metabolic rate of the animal begins to rise with a corresponding rise in body temperature. In this region of high environmental temperature the temperature regulation breaks down, the metabolic rate begins to follow Vant Hoff's law, and if this condition is maintained long enough, the animal dies of overheating. The relative humidity of the air plays an important role. In dry air, animals can stand higher temperature than in moist air. In the region above the critical temperature, food intake increases the metabolic rate.

In abnormally high environmental temperature the metabolic power of the animal may be impaired. Very little is known at present on this point. The use of isotopes as tracers will be of great help in studying these important problems.

He stated that the effect of environmental temperature on food utilization of baby chicks appeared to increase as a linear function of decreasing temperature, and the gain (as chemical energy of body substance) showed a maximum at an environmental temperature of 32°C. The total efficiency gain/food showed the following relation to environmental temperature :—

Environmental temperature °C.	=21	27	32	38	40
Energy in gain of body substance 100	=10	18	23	23	20

The effect of environmental temperature on food utilization of 3 Jersey cows was measured in the California respiration apparatus for cows. The results showed that cows endured rather low temperatures without suffering. Attending the cows in the chamber at low temperatures, they shivered, but the cows seemed perfectly happy. Their food intake and their heat production increased only slightly when the environmental temperature was lowered from 18 to 7°C. Milk production remained at the same level, but the loss of body substance increased slightly so that the total efficiency of utilization of metabolizable food energy decreased from 38% at 18°C. to 33% at 7°C. Much more disastrous for the well being of the cows and the efficiency of their food utilization was the rise in environmental temperature to 30°C. Food intake decreased from 600 to 380 Kcal per $Kg^{3/4}$ of body weight. Heat production remained practically equal. Milk production dropped slightly but a considerable loss of body substance occurred so that the total efficiency of food utilization (accounting for milk as body substance) dropped from 38% of the metabolizable food energy at 18 to 13% at 30°C.

At a low environmental temperature the calorigenic effect of the food is utilized in keeping the animal warm. At high environmental temperature, the calorigenic effect of food adds to the stress of the environment and decreases the appetite and thus the total efficiency of food utilization.

In winding up the discussion, the Chairman Dr. Kehar thanked all the participants for their interesting deliberations and was glad to see that the scientists were paying more attention to the influence that the climate and diet can play in the improvement of the efficiency of man and animal. He pointed out that several workers have stressed that the high atmospheric temperature stands not only in the way of high productive efficiency but also in improvement of the health and well beings of man and animal.

He appealed in the form of a resolution to the authorities of the Union and State Governments and of the private organisations to become more conscious about these branches of physiology and advocated to consider them equally with heridity and management for the improvement of the livestock population. This effort will maintain the optimum productive efficiency of the livestock population which in turn will feed the human population with optimum quantity of milk, a complete food, for maintaining normal health and activity.

XX. CULTURAL DIFFERENCES AND GROUP CONFLICT

Section of Psychology and Educational Science.

Chairman: **Mr. J. M. Sen**, Calcutta.

1. **Mr. K. C. Mukherjee**, Calcutta, opened the discussion.

The study of mere cultural differences of the groups may be anthropological and not really so much psychological.

It is difficult to find out reason why such recognition of differences should, in itself, breed animosity and be incapable of attraction and friendliness. Tension comes about when the differences frustrate the self-determining impulses and wishes of the individuals. The difference is only an element in the total situation, sometimes it may be only a symptom, and not a cause of the disease.

Behind the group tension there is a conflict of interest. The cultural differences may be irrationally exaggerated and used as a weapon in the hands of the politicians, when false charges and irrational indictments are made by the leader a delusional disorder of the mass-mind takes place. Individual inner super-ego disappears, the barriers of repression are lifted, inner responsibility is thrown off. So the effective development of the social super-ego is necessary to combat communal fury or tension.

2. **Mr. Krishna Kumar** (Kanpur):

(*a*) Cultural differences need not but contain the seed of conflict. The process of canalization and condition by which creates a cultural pattern also leads to attitude of approval of our own cultural patterns and disapproval of other and different patterns. The child if allowed to play and mix with other children may pick up other behaviour and attitudes but may meet with disapproval and criticism from his elders. Such super-ego restrictions remain in the leakage of mind and during adult life they can be exploited by any leader in a critical situation and thus lead to conflict.

(*b*) The remedy lies in creating oblique interests and activities where people can cooperate and differences become complementary. But in a society where competition is the main motif it is difficult to create an atmosphere of cooperation. The feeling of insecurity engendered in a competitive society can activate the canalized differences to engender conflict. A communistic state offers greater scope for developing cooperative and objective attitudes than a democratic pattern where individualism offers greater scope for engendering competitive and conflicting attitudes.

(*c*) Super-ego and conscience must be distinguished; the former is authoraterian and unconscious while the latter is rational, conscious and purposive. It is the development of a social conscience rather than of a social super-ego which that will help in fusion and assimilation of cultures through creating an interest in objective attitudes and cooperative endeavour in which differences complement each other in the interest of social welfare.

3. **Mr. Durganand Sinha** (Patna) :

Cultural differences are not the cause of group-conflict. Cultural differences by themselves are not bad; on the other hand, they lead to the richness and variety in our social life. The situation is complicated because of the factor of *competitiveness* in our group-ridden society.

Conflict arises only when there is *blocking* of certain motives or drives. In a social situation, there are diverse groups with their respective group-goals. Due to the competitive nature of our society, a situation often arises when it is found that the satisfaction of one group-goal is incompatible with the satisfaction of group-goals of other groups. And a *blocking* occurs. Tension results in two ways : (1) when the satisfaction of a group-goal is *actually* blocked, or (2) a group *expects* that it will be blocked by others. Therefore, group-tension may exist even when there is no actual frustration of a goal, but simply there is *expected* frustration.

Here cultural differences and the process of canalization play their part. They engender certain attitudes that result in *expectancies* on the part of member of one group towards other groups. This factor of *group expectancy* is something which cannot be ignored. As a result of group expectancy, a member of one group starts to anticipate certain thing from the member of other groups which are in a state of competitiveness. If the frustration and blocking of group-goals is expected, a full-fledged conflict situation arises. Here it is interesting to note Cantil's very interesting theory of *social perception* : a social perception is a bind of a diagnosis of how members of other groups are going to affect us in our activities which are directed towards the satisfaction of certain goals. So, according to the speaker, the problem of group conflict is largely rooted in *social perception.*

One of the remedies of group conflict, according to the speaker, is changing our *group expectancies* in which groups are not viewed as frustrating their respective goals. It is only by a widening of outlook, enlarging our attitudes that this can be achieved. This can be by changing to some extent the organization of our social structure.

4. **Prof. V. K. Kothurkar** (Poona) :

Cultural differences—not the cause of conflict. Competitive organization of society is the cause. Attitudes—not independent of basic pattern of society. Co-operative pattern—helpful to minimize conflict. Cooperation, team-work, planning —not necessarily authoritarian. Democracy provides room for organization of different roles and reconciliation of interests.

5. **Prof. Kali Prasad** (Lucknow) :

In summing up the discussion I find two opposing trends which have appeared. One, according to which cultural differences do not necessarily make for group conflict and second, according to which cultural differences have in them the roots of conflict. Solution or resolution of the conflict according to the latter view would be possible when complete cultural homogeneity is attained. This is a strange view. One would have thought that in view of the recent history of Europe the fatal consequences of such a view had become obvious. Attempt at securing homogeneous pattern of culture is bound up with authoritarian modes of thinking and savours too much of totalitarianism to find acceptance in any social democratic structure. The special merits of democracy consist in equality of opportunity for the development of individuals and groups. The world as it exists has variegated patterns of group behaviour and these differences lend richness to the complex character of the society today. Democracy pre-supposes cultural pluralism. Instead of subdueing the differences, the experimentally approved way is to adjust and to integrate them. A differential situation evokes differential responses and thus serves to answer to the needs of the multidimentional personality and offers opportunity for its fullest development.

Even where there is uniformity in culture we find that group conflicts occur; perhaps because they arise from different kinds of competition and hostility (for example, economic, political, social, ethnic antagonism). The mechanism of the conflict, therefore, would seem to lie not in cultural differences but in the *failure of adaptation to them.* For, as had been said above, differences are basic and desirable characteristics of the various cultural strata and cultural composition. They stem from physical-geographical, social-historical, and other demographic and environmental factors. They also spring from early training and behaviour habits. It is well-known that children brought up in authoritarian atmosphere or with ethnocentric bias are much more prone to attitude resulting in conflict than tolerant children. Experimental studies by Frenkel Brunswik and Rokech have shown the basic continuity of prejudice in children with their general personality characteristics as adults. Such children (when they grow as adults) have less tendency to think of social problems in long range term and more in terms of immediate welfare; greater projection of hostility to outgroups; greater respect for strength and greater hostility toward weakness, more submissive attitude toward authority (or as a reaction formation, a greater revolt against authority), more superstitious sense of catastrophic and chaotic forces in the world, etc., etc. These incipient patterns in the children studied (ages 11 to 16) grow more marked with age.

From a study of this kind and from anthropological evidence available today, it may be held that group conflicts (much as individual conflicts) arise from differences in methods of training and learning and from the composition of the social structure. This does not, however, mean that there is any one single method of learning or training but it would be obvious that here are certain modes which are more effective and have greater adaptive value than others. It is these that have to be employed and others to be modified or to be eliminated. It must also be pointed out that the importance of early training specially weaning and toilet training have been overemphasised by the Fridians culture personality school of Linton-Kardinar. This over emphasis has led, for instance, to certain over simplifications in studies of national character (for example, study of the Japanese character). The methods have then to suit the requirements of the person in the social environment in which he lives. The developing and ministering to the needs of the individual or the group is the great task of the educator and the social reformer. The best social structure so far discovered for this purpose is the democratic structure because in it there is ample room for the development of the person and groups and for their *integration.*

Group differences must be recognised; they exist even if they are not biological in nature. It should be recognised too that many undesirable traits in a minority, as Zawadski notes, are reactions against prejudice and can be unlearned under changed conditions. Zawadski proposes 'a convergence theory which takes into account objective factors of group difference as well as the role of their transformations and projection.' It has become reasonably clear to social psychologists and others today that the resolution of tensions and conflicts is possible by experimentally ascertained methods of reducing prejudice, hostility, anxiety, segregation, insecurity, etc. Education and social adjustment, psycho-therapy and group-therapy are techniques which must be brought into play against tensions and group conflicts. Along with economic and political adjustments there is considerable need for the education of the young children the world over in the methods of understanding, free-association, tolerance, and fellowship. Their familial and social economic conditions must be such as would facilitate the development of these characteristics and would make for the reduction (if not elimination) of hostility, anxiety state, fear and insecurity. The resources of research must be concentrated on this problem of training and education in the arts of social understanding and social integration. It is believed today that such an integration can be achieved. The international agencies like the UNESCO and UNO have been inspired by this belief.

XXI. MINERAL DRESSING IN INDIA

Section of Engineering and Metallurgy.

Opening remarks by the *Chairman*: Dr. S. K. Sircar (Kusunda, Bihar):

Ores and minerals as mined are seldom found in a pure or even highly concentrated state. They are always associated with foreign matter such as rocks, minerals, vein materials, etc., which have to be ultimately eliminated as best as possible to get the value contained in the deposit, in a suitable state for utilisation. The proportion of associated foreign matter varies and it is invariably found that the rarer and the more valuable the ore or mineral is, the greater is the proportion of the foreign matter or gangue. The methods of collecting the value contained in ores and minerals to produce concentrates suitable for marketing and utilisation is commonly known as "Ore Dressing". They have been steadily developed by Mining Engineers and Technologists, beginning from the early days of the metal mining industry, well over a century ago and have now reached such an advanced stage, that ore dressing may be called an art.

The methods of concentration employed, are essentially based on the physical properties of the minerals such as specific gravity, hardness, tenacity, fracture, aggretion, adhesion, surface energy, electric conductivity, magnetic permeability and decrepitation. The first stage in the process is size reduction which affords a means of liberating the ore or mineral contained in the rock, and screening to suitable sizes for subsequent treatment. The degree of size reduction required, depends upon how intimately the mineral is associated with the gangue. In many cases, extreme size reduction has to be resorted to before maximum possible economic recovery can be expected.

For subsequent treatment, those most extensively used, are the wet methods such as Jiging, utilising the difference in specific gravity and ability to settle in a pulsating current of water. Tables and Vanners, in which the principle involved, is much the same, but the size treated is fine and pulpy. The accidental discovery of Elmore Bros. in 1898 that certain minerals, though heavier than water, when in a fine state, possess the property of attaching themselves to bubbles of air and float, ultimately led to development of methods of Froth Flotation which now dominate the field so far as treatment of finely dissiminated minerals, tailings, slimes and slurry are concerned. It is one of the most ready means of attacking the problem of mineral concentration. The mineral matter constituting ash in many of our coals is so finely dissiminated that such coals are considered not readily amenable to ordinary methods of cleaning and washing. This method of treatment is likely to play an important role in cleaning such qualities of our coal deposits, since size reduction of coal is easy, comparatively inexpensive and coal, even though not very finely ground, can be readily concentrated by froth flotation, in many cases, without the use of much reagent.

Of the dry methods, those based on magnetic and electrostatic properties have assumed more importance during the late years and are in more extensive use. The use of Magnetic Separators for concentrating Zonazite from sand is well known. This method is in use in our country for recovery of Monazite in Travancore.

Hitherto, methods of ore dressing have not been in use to any appreciable extent in this country since our mining industry has been very largely confined to coal the quality of which being reasonably good in the past, there was little inclination to attempt dressing and preparation before marketing. Besides, the price structure in those days did not favour any such attempt which was bound to meet with economic failure. Times have changed since then; the quality of coal mined, has gone down steadily and will continue to do so in future and the prices have gone up considerably. The consumer is naturally more conscious of his right to demand quality and the producer's obligation to ensure it. Already two large size coal cleaning plants based on the float and sink method using dense medium for separation, have come into existence and a few more are sure to spring up in future. Unfortunately, the common impression that this is the only method suitable for treating Indian Coals, is proving a deterrent to future progress. It will suffice to mention here that this method has its limitations and there are several other methods of proved efficiency and economy, available, to suit conditions and each case has to be treated individually;—what is good for one, may not be applicable to the other to produce the same results. Extreme size reduction may not always be considered uneconomic.

Another mineral very largely mined in India and exported is Manganese. As in the case of Coal, no appreciable attempt has hitherto been made to dress and prepare it before placing in the market. However, prevailing conditions now demand adequate attention to this aspect.

The Indian Copper Corporation are known to have been using the method of Froth Flotation in this country for a considerable time for concentration of copper ore mined in the Singhbhum District of Bihar. I believe, they are pioneers in this country in this respect. To meet urgent War requirements, more ore and metal mines came into existence in this country and this has naturally widened the scope for application of methods of Ore Dressing.

From the number of papers received for discussion, it is evident the country is not unconscious of national requirement and Ore Dressing is sure to pay an increasingly important part in developing our mining industry in future.

I take this opportunity to thank all the authors for their valuable and highly interesting contributions, which, I am sure, will stimulate helpful discussions.

1. Dr. S. Guruswamy (Jealgora, Bihar):

The Screening of Coal for Commercial purposes

Coal as mined (run of mine coal) consists of a wide range of particle sizes. Generally equipments that use coal are designed for particular sizes (or range of sizes) and hence there is need for screening run of mine coal to obtain sized products. The type and size of screening plants needed for the purpose will depend on the tonnage to be handled and the number of sized coals needed. For commercial coal screening, trommel, grizzly and shaking screens are usually used.

The trommel has a number of concentric screens arranged so that the centre has the largest and the outer screen the smallest opening. The set of screens is kept inclined and is rotated. The feed is introduced into the centre screen. In some trommels, a long single revolving cylinder punched with openings of different diameters replaces the concentric screens.

The grizzly screen consists of a number of parallel bars kept at fixed distance from one another: the opening between the bars corresponds to the size of the product needed.

As the name implies, shaking screens have a mechanism for shaking the coal to facilitate its screening. Shaking screens consist essentially of shallow rectangular box two to four or more times as long as wide with screens serving as the bottom of the box. They are kept inclined 10 to 15° to facilitate the flow of coal. Shaking screens are widely used for the commercial screening of coal.

The capacity of a screening plant depends on the efficiency of screening desired; capacity is increased if a high efficiency of screening is not desired and vice versa. The screening efficiency will depend on a number of factors. Some of them are:

- (*a*) The size distribution of the feed with reference to the screen opening.
- (*b*) The shape of the material that is fed into the screen.
- (*c*) The amount of shaking given to the feed.
- (*d*) The per cent area opening of the screens and the thickness of the screen plate.

In general, it can be stated[1] that the coal particle is rectangular in shape and is roughly twice as long as it is wide and about half as thick as it is wide. For a given screen opening, it has been estimated[2] that particles whose size ranges from 150% to 75% of the screen opening will take the maximum time for screening.

While shaking is necessary to improve the rate of screening, too much or too little of it can retard the rate; the former by imparting a large speed to the coal particle and the latter by blinding the screen. The right amount of shaking needed can only be judged from experience.

The per cent area opening that can be allowed in the manufacture of the screen depends on the strength of the plate used. An increase in the per cent area opening will increase the capacity of the screen when other things are constant.

It would appear from above that a reasonable efficiency of screening can be attained under practical conditions. If the demand for sized coals are restricted to certain standard size groups, the commercial marketing of coal will be greatly facilitated. Such standardization of size groups will benefit the producer, consumer and the nation. For the producers, full value for coal is realized by developing a steady demand for the different sizes of the run-of-mine coal. For the consumers, coal of standard size groups will be available with the least delay and cost. From the national point of view, waste is avoided by properly matching the different sizes of coal produced by the collieries against the size requirements of the consumers.

In the United Kingdom, a scheme for the standardization of the size groups has been formulated jointly by the British Coal Utilization Research Association and the British Colliery Owners Research Association and accepted by the National Coal Board. The U. K. Scheme is based on a detailed survey[3] of the existing practice among the coal producers and consumers.

In India the work of standardization of size grading of coal for marketing has been taken up by the Indian Standards Institution through their Solid Fuels Sectional Committee. The F. R. I. is co-operating in this work.

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[1] Needam and Hill, Fuel, 14 (1935), 222.
Guruswami et al, The size & shape of broken coal I to IV (under publication).

[2] Handbook of Mineral Dressing by Taggart, John Wiley (New York), pp. 7-04.

[3] Statistical report on the size grading of coal by R. L. Brown, (1947), issued jointly by B.C.U.R.A. and B.C.O.R.A.

2. **Dr. A. Lahiri** (Jealgora, Bihar) :

Floatation of Minerals

Fundamentals of froth floatation technique has been reviewed and the mechanism of functioning of frothers, collectors, activators and depressants commonly used in floatation has been discussed. It is pointed out that coal has a natural floatability, but this property changes with the petrological composition of coals. It is observed that the kinetics of floatation is still a controversial subject.

Possibilities of application of the flotation technique in India to coal preparation and concentration of valuable minerals are surveyed. The high cost of drying of flotation concentrates militates against the use of the technique for recovering low cost materials like coal; sun-drying has been mentioned as a possible way of cheapening the costs.

3. **Mr. J. K. Ghosh** (Kusunda, Bihar) :

Froth Floatation : Possibilities of its application in India for cleaning Coal

Manufacturers of metallurgical coke in the country have been experiencing constant difficulty in procuring suitable coal for its manufacture from sometime past. In fact, the position as it stands now is acute. India has large reserves for coking coal, but their abnormally high ash content made them not only unsuitable for metallurgical use, but also uneconomic for other purposes. In order to ensure regular supply of metallurgical coal, their beneficiation by cleaning operation is mandatory.

Laboratory tests so far done reveal that cleaning processes based on gravity separation methods do not suit most of Indian Coals. For such coals and for middlings of gravity separation processes, beneficiation by 'Froth Floatation' is expected to give better performance.

XXII. INDUSTRIAL DEVELOPMENT IN THE DAMODAR VALLEY

Section of Engineering and Metallurgy.

Opening Remarks by the *Chairman* : **Dr. S. K. Sircar** (Kusunda, Bihar).

The Damodar Valley Project is probably the first bold step taken by Free India to further our national cause by harnessing nature to the service of man. The mighty Damodar, known as the river of destruction through ages, will have an end to its mad and erratic career. She already has a formidable record of drowning death and destruction and we have already sunk a collossal amount of capital in our attempt to bring her under control and serve some useful purpose. Whether our attempt will succeed or it will be simply ignored by nature, as she often did in the past, is for the future historians to record. At this stage, we must rely on an all out concerted effort to make the scheme a success.

The Damodar Valley Corporation, since its inception, has often come under adverse criticism whether merited or not. Such criticism is sure to be faced by sponsors of any huge scheme and more particularly when it has to be executed during the period when conditions within and outside the country are changing rapidly. Nevertheless, we live for the day to see satisfactory completion of the scheme to function as conceived and to think those who had boldness and vision to take such a decisive step for the good of man.

A reference to the map leaves no doubt that no better scheme could have been selected for our first attempt to develop river valley projects. The three essential requirements for industrial development are fuel, water and power. There is an abundance of fuel within the area covered, and when completion of the scheme results in supply of the other two, in plenty, there is bound to be a natural tendency of industry to grow, thrive and prosper in this area, which is already industrialised at places.

The potentialities of the Asansol area, at present highly industrialised and growing very fast, are immense for further industrial development. The two proposed lakes at Maithon and Panchet Hill on either side, hydro-electric station at Maithon and the proposed Canal from Durgapore to the river Hooghly, when completed, will undoubtedly make this area ideal for developing highly integrated industries. Since lack of simultaneous existence of allied industries is not conducive to economic industrial expansion and our past experience shows that it is acting as a clog in the wheel, in our industrial progress every now and again, establishment of a selected few basic industries around with innumerable subsidiary industries may develop not only to utilise the by-products and industrial wastes of the parent organisation, but also to feed it ultimately by keeping up supplies to meet at least some of its requirements appears to be a move in the right direction and conducive to rapid progress. In highly integrated stage, the parent concern becomes a finishing centre on mass scale, based on supplies of finished and semi-finished components to make up the whole, from satellite concerns which may even include cottage industries. The benefits of industrialisation can thus be evenly spread, opening up possibilities of employment and opportunities of earning for millions.

If we consider the automobile industry for a moment, we find that only one such industry can support an innumerable number of subsidiary industries and manufacturers to supply thousand and one component parts required to manufacture car and trucks. If the scope of work is extended to manufacture of Tractors, heavy machinery and the like, the possibilities are still further increased. Iron and Steel plants already exist in this area. More Blast Furnaces and Coke Ovens can be set up if the situation demands it. There is likely to be ample supply of surplus gas for open hearth steel furnaces if set up. There will be plenty of scrap iron available, for remaking into finished steel. It is certainly more economic to utilise them within the country than exporting to Japan and import them in form of finished steel at an enormously enhanced rate.

All that is required at this stage is for the State to set up an adequate number of units to turn out primary, semi-finished products and ultimate finishing units such as assembly plants, etc., to buy back finished components and parts from independent satellite industries and manufacturers. I am afraid, the time available for the discussions does not permit dilating on the subject any further. I may only indicate that this area is yet to see at least a few more thermal power stations to supply electric power to the Railway for traction and to meet industrial load, highly integrated with processing industry and manufacture of coal chemicals.

This area, the most important centre for manufacture of Soft Coke, is yet to see abolition of present day wasteful methods and introduction of modern scientific methods of preparation of coal, manufacture of soft coke and recovery of by-products —the latter, when available in quantity is sure to lead to manufacture of coal chemicals and organic raw materials for synthesis and ultimately a vast chemical industry manufacturing organic dyes, pharmaceuticals and what not.

1. Dr. B. C. Guha (Calcutta) :

Damodar Valley Project.

The Damodar river runs through the States of Bihar and West Bengal and its drainage area covers 8,500 square miles. The project consists essentially of constructing—

(*i*) Eight dams on the Damodar and its tributaries with hydroelectric stations and two auxiliary plants with a total installed capacity of 240,000 kw.; the total controlled reservoir capacity would be 4·7 million acre-feet and should protect the valley from floods up to 1 million cusecs;

(*ii*) A thermal power station, utilising low grade coal, of 200,000 kw. installed capacity to even out the seasonal fluctuations of hydro-electric power and to provide, in combination with the hydroelectric system, firm power of 300,000 kw. capacity at 60% load factor;

(*iii*) A power transmission grid covering 475 miles of 132 kv. primary line with necessary lengths of 66 kv. and 33 kv. secondary lines, and

(*iv*) A barrage and a 90-mile long irrigation-cum-navigation canal with a system of distributaries measuring 1,553 miles in length and irrigating a million acres of fertile land.

In the first phase of the project, however, four dams are being built at Tilaiya, Konar, Maithon and Panchet Hill. These are expected to control the highest flood so far recorded *viz.*, about 650,000 cusecs. Of these Tilaiya has been practically completed, Konar will be completed by June 1953, Maithon by June 1954 and Panchet Hill and the Barrage at Durgapur by June 1955. All the canals should be completed by June 1956. At the same time a high tension transmission grid which has already taken surplus power of Sindri and delivered it to Chittaranjan Locomotive Works and coalmines in Sibpore, Luchipore, Kumardhubi and Ranigunge, will connect up Jamshedpur, Ghatsila, Khargpur and Calcutta. It is expected that in due course the railway between Calcutta and Moghulsarai will be electrified. An intensive mineralogical investigation of the Damodar valley and its adjacent area has shown great possibilities of industrial development utilising the power and water made available by the project. This area appears to be the most highly mineralised area of its size in the world. It contains 80% of India's coal, 80% of India's mica, the richest iron ores, bauxite, steatite, kaynite, and different clays which could be used in refractory industries. The possibility of development of industries based on all these materials is immense. An economic analysis of the project indicates that on an investment of 90 crores of rupees in the project spread over seven or eight years, an annual production of foodstuffs worth 30 crores of rupees and an annual industrial production worth about 400 crores of rupees should be feasible. This will, however, require a planned, coordinated and intensive effort in several sectors of the national economy.

2. **Dr. N. V. Raghunath** (Jadavpur, Calcutta) :

Refractory Material Industry in Damodar Valley—Its present and future Activity.

The speaker dealt with the Refractory Industry in India and its present position and future possibilities. The Damodar Valley contains all the necessary raw materials for starting refractory industry. Some comparisons are shown regarding the refractory industry in U.S.A., Geater Germany, Switzerland and India. The various lines of development of other industries are indicated where refractories play a predominant role.

3. **Dr. J. W. Whitaker** (Jealgora, Bihar) :

Coals of the Damodar Valley Coalfields.

The paper reviews the types of coal found in the Damodar Valley in Bengal and Bihar. It is shown that the coals comprise the meta-lignitous, and meta-, ortho- and para-bituminous types of Seyler. The second part of the paper discusses the composition of impurities present. The coals have low sulphur (0·5 per cent) even when the ash is high. The ash constitutes about 90 per cent of the mineral matter, the remainder being largely water of hydration. There is a brief treatment of the washability of the coals, and a note on the 'Jhama' or semi-carbonised coal encountered in the mines.

4. **Mr. F. S. Watcha** (Jamshedpur) :

Possibility of Utilization of Methane in Damodar Valley Area.

Methane is an additional source of fuel which can be profitably extracted and used. It is freely available in some mines and no drying or purification is required. Systematic recovery of methane from mine workings has been practised in Europe and with its increasing use much knowledge has been gained about the storage in coal seams and the strata above and below the coal seams. Various methane recovery methods are described. Attention is drawn to the availability of methane in the coal fields of Bokaro and the plan suggested for harnessing it for industrial use. This paper stresses the necessity of starting experiments and gathering data for the recovery of methane for commercial use.

5. **Dr. V. R. Khedker** (Director, Indian Bureau of Mines) :

Industrial Prospects of the Subarnarekha Basin in the D.V.C. Operational Area.

The author puts forth here a comprehensive plan for the overall development of the mineral resources of the Subarnarekha basin. The proposal indicates a multiplication of the revenue from the minerals of the area and a considerable upgrading of the standard of living of the residents of the region.

The investigations of the author and his associates have proved that the ore hitherto worked for copper only is indeed a wonderful ore capable of yielding appreciable tonnages of sulphur, P_2O_5, nickel and titanium on proper processing including economic quantities of radio-active ores in the Subarnarekha basin. In addition, this area produces the bulk of the finest quality kyanite in the world and is contiguous to the Keonjhar Manganese and Mayurbhanj Vanadium Deposits.

The author suggests the setting up of a series of integrated plants at suitably selected localities within the basin for the manufacture of electrolytic copper (together with recovery of gold), super-phosphate, sulphur and sulphuric acid, high grade refractories, ferro-manganese and possibly ferro-vanadium. Except for the last three products, the manufacture of all the others will depend wholly or partially upon the proper treatment of the above ore.

It is computed that these schemes on being implemented, will raise the earnings from the mineral trades and industries of this area to Rs. 20·5 crores against the present figure of Rs. 6·5 crores, including a recovery of Rs. 1·2 crores as export duties and proportionate returns of income-tax, apart from the benefits of larger employment and the betterment of the standards of living.

All these improvements depend entirely upon the supply of power from the Bokaro thermal station, which is guaranteed by 1953. Further, a colossal quantity of power will be used up by another plant of the greatest national importance which is likely to come up shortly within the basin. Hence power from Bokaro alone will prove inadequate for all the plants indicated. It will thus be necessary to locate and develop additional sources of power.

This additional power can easily be obtained by harnessing the Subarnarekha and its important tributaries. Several sites likely to be suitable for the purpose are provisionally suggested. The dam-building organisation at the disposal of the D.V.C., which at the end of another two or three years will have completed its present programme, can, with great advantage, be diverted to the Subarnarekha basin.

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